Risk Communication

in Public Health and Health Security

Habilitationsschrift

vorgelegt am 30. Juni 2017

der medizinischen Fakultät

der Friedrich-Schiller-Universität Jena

von

Dr. med. Dr. phil. Petra Dickmann MA

aus Düsseldorf

Gutachter:

1. Prof. Dr. Michael Bauer, Friedrich-Schiller-Universität Jena

2. Prof. Dr. André Scherag, Friedrich-Schiller-Universität Jena

3. Prof. Dr. Manfred Wildner, Ludwigs-Maximilians-Universität München

Erteilung der Lehrbefähigung am 10. Juli 2018

Ehrenwörtliche Erklärung

Ich erkläre hiermit, dass mir die Habilitationsordnung der Friedrich-Schiller-Universität Jena vom 07.01.1997 bekannt ist.

Ferner erkläre ich, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Die aus anderen Quellen direkt oder indirekt übernommenen Daten und Konzepte sind unter der Angabe der Quelle gekennzeichnet. Bei der Auswahl und Auswertung folgenden Materials haben mir die nachstehend aufgeführten Personen in der jeweils beschriebenen Weise unentgeltlich geholfen:

1. Alle Autorenbeiträge sind in den jeweiligen Publikationen separat beschrieben

Weitere Personen waren an der inhaltich-materiellen Erstellung der Arbeit nicht beteiligt. Insbesondere habe ich hierfür nicht die entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten in Anspruch genommen. Niemand hat von mir unmittelbar oder mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Arbeit stehen. Die Arbeit wurde bisher weder im In-noch Ausland in gleicher oder ähnlicher Form einer Prüfungsbehörde vorgelegt. Ich versichere, dass ich nach besten Wissen die reine Wahrheit gesagt und nichts verschwiegen habe.

Jena, den 30. Juni 2017 Petra Dickmann

Erklärung zur Zulässigkeit des Antrages (§3, Abs. 2 HabilO)

Ich erkläre, dass ich an keiner anderen Stelle ein Habilitationsverfahren für das Fachgebiet PUBLIC HEALTH beantragt bzw. erfolglos beendet habe,

Jena, den 30. Juni 2017 Petra Dickmann

Contents

Abstract

Risk communication is a core capacity under the World Health Organisation's (WHO) International Health Regulations (2005) and an important part of modern public health practice. However, while international legislative frameworks set the scope of risk communication, there is a demand for increasing and improving evidence and skills in risk communication research, policy and strategy development, evaluation of practice and sustainable capacity building.

This cumulative habilitation describes the major contributions to the field of risk communication in public health and health security both at a thematic, content level of risk communication research policy and practice and at a broader methodological level. It introduces the new conceptual paradigm of risk communication that moves risk communication from being a technical capacity to convey health risk information to a targeted audience to a governance approach with three strategic axes of information (gathering, assessing and sharing), communication (strategies, key messages and means of communication) and coordination (at various administrative levels). It introduces a new system to understand risk communication practice by providing a matrix of risk communication activities, such as information (listening), communication (relationship-building) and coordination (supportive environments) across the lifecycle of an event, e.g. outbreak, before, during and after. Adopting this new perspective can generate innovative insights, as demonstrated in the field of antimicrobial resistance. The new paradigm and its methodology can also support strategy development at health policy level and facilitate the assessment of public health security. The Marburg Biosafety and Biosecurity Scale (MBBS) is a framework for rational risk assessment and risk communication and offers a new metric to assess biosafety and biosecurity that can also guide capacity building in these areas.

Evaluation of public health interventions is essential to monitor progress, identify and assess areas for improvements and demonstrate useful outcomes and overall impact. The Earlier – Faster – Smoother – Smarter approach is an original framework to monitor, evaluate and guide risk communication activities for earlier detection, faster response, smoother coordination and smarter legacy that were applied in two case studies (Ebola, earlier detection).

Risk communication in public health and health security has important thematic outputs with significant outcomes and impact. The applied, new methodology is a social laboratory format that is social, experimental and systematic and has the potential to become a genuine methodological category. Both, content and methodological approaches, contribute to a

framework for a sustainable implementation of the new risk communication paradigm in public health research, policy and practice.

Zusammenfassung

Risikokommunikation ist eine Kernkompetenz im Rahmen der Internationalen Gesundheitsvorschriften (IGV 2005) der Weltgesundheitsorganisation (WHO) und ein wichtiger Teil moderner Gesundheitssysteme und öffentlicher Gesundheitspraxis. Während die internationale Gesetzgebung den Geltungsbereich der Risikokommunikation festlegt, besteht die Forderung nach mehr und besserer Evidenz und Kompetenz in der Risikokommunikationsforschung, ihren gesundheits- und sicherheitspolitischen Implikationen, der Strategieentwicklung, der Evaluation der Praxis und dem nachhaltigen Kapazitätenaufbau.

Diese kumulative Habilitation beschreibt die wichtigsten Beiträge zur Risikokommunikation in der öffentlichen Gesundheit und Gesundheitssicherstellung sowohl auf einer thematischen, inhaltlichen Ebene und auf einer breiteren methodischen Ebene. Diese Arbeit stellt das neue Paradigma der Risikokommunikation vor, das Risikokommunikation von einer technischen Fähigkeit zur Vermittlung von Gesundheitsrisikoinformationen an ein Zielpublikum zu einem Governance-Ansatz mit drei strategischen Achsen der Information (Erfassung, Bewertung und gemeinsame Nutzung), Kommunikation (Strategien, Kernbotschaften, mediale Formate) und Koordination (auf verschiedenen Administrationsebenen) entwickelt. Sie stellt ein neues System vor, um die Risikokommunikationspraxis besser zu verstehen, indem es eine Matrix von Risikokommunikationsaktivitäten wie Information (Zuhören), Kommunikation (Beziehungsaufbau) und Koordination (supportive Umgebungen) über den gesamten Zeitraum eines Ereignisses, z.B. ein Infektionsausbruch, beschreibt (vorher, währenddessen, danach). Diese Perspektive kann innovative Erkenntnisse erzeugen, wie auf dem Gebiet der antimikrobiellen Resistenz gezeigt wird. Das neue Paradigma und seine Methodik können auch die Strategieentwicklung auf gesundheitspolitischer Ebene unterstützen und die Bewertung der Gesundheitssicherheit erleichtern. Die Marburg Biosafety and Biosecurity Scale (MBBS) ist ein konzeptioneller Rahmen für eine rationale Risikobewertung und Risikokommunikation und bietet eine neue Metrik zur Bewertung von Biosafety und Biosecurity, die auch den Kapazitätenaufbau in diesen Bereichen leiten kann.

Für die Evaluierung von Interventionen im Bereich der öffentlichen Gesundheit ist von wesentlicher Bedeutung, die Fortschritte adäquat beurteilen zu können, sowie Bereiche für Verbesserungen zu identifizieren. Der Earlier-Faster-Smoother-Smarter Ansatz ist ein neuer Rahmen für die Evaluierung von Risikokommunikation, der zu früheren Detektion, einer

schnelleren Reaktion, einer besseren Koordination und wirksameren Policy führen kann, der in zwei Fallstudien angewendet wurden (Ebola, frühere Detektion).

Die Risikokommunikation im Bereich der öffentlichen Gesundheit und der Gesundheitssicherheit liefert wichtige thematische Ergebnisse. Die angewandte, neue Methodik ist ein soziales Laborformat („Social Laboratory“), das sozial, experimentell und systematisch ist und das Potential hat, eine eigene methodische Kategorie zu werden. Sowohl Inhalt als auch die methodischen Ansätze können zu einer nachhaltigen Umsetzung des neuen Risikokommunikations-Paradigmas in Gesundheitssystemen und öffentlicher Gesundheits-praxis beitragen.

I. Introduction

This introduction gives a brief overview of the field of risk communication research in public health and introduces the main contributions to the field of risk communication in public health and health security both at a thematic, content level of risk communication research and at a broader methodological level.

The first chapter introduces the international legislative framework of risk communication practice and its recent developments. It then outlines the demand for evidence in risk communication research, strategy development, assessment and evaluation as well as teaching and training formats for a new risk communication practice. The second chapter introduces the key concepts of risk communication that respond to the need for research, policy and practice. It describes the contributions to the new paradigm of risk communication in public health both from a research perspective and as a methodological approach. Building on the paradigm shift in risk communication research, advances in strategy development at policy level and assessment and evaluation tools are described. Finally, a case study on Ebola and on earlier detection exemplify the new risk communication paradigm in public health security practice.

The third chapter summarises an outlook at content, practice level of risk communication and as a methodological approach; it concludes with a brief description of a framework for a sustainable implementation of the new risk communication paradigm in public health research, policy and practice.

1. Risk communication in public health and health security

Risk communication as a technical term and theoretical concept has undergone significant changes and reflect current societal developments. The same is true for the concept of public health – and the more recent introduction of the public health security concept.

Public health security and risk communication – international legislative framework

Infectious agents and diseases can pose public health risks through natural occurring outbreaks, accidental or intentional release from laboratories or through misuse of pathogens in biological weapons. This ambivalence of infectious diseases as naturally occurring or intentionally manipulated threats is expressed in the term “dual-use”.

Public health risks that can cause international concerns are a matter of increasing political awareness and higher priority on the international political and scientific agendas (e.g. G7, Global Health Security Agenda, G20, etc.) and was even part of the Munich Security

conference in 2017.[1]

International Health Regulations (2005)

In the aftermath of the outbreak of "Severe Acute Respiratory Syndrome" (SARS) in 2002, the international community and the World Health Organisation (WHO) updated and implemented the revised International Health Regulations in 2005 (IHR 2005) that request from all Member States to build the capacity to prevent, detect and respond to public health emergencies that can spread internationally or cause damage to the international community. The IHR (2005) identify eight core capacities that Member States need to develop, strengthen and maintain. Risk communication is one of the core capacities under IHR (2005) and is understood – following the definition of WHO – as "*a multi-level and multi-faceted process, which aims to help stakeholders define risks, identify hazards, assess vulnerabilities and promote community resilience, thereby promoting the capacity to cope with an unfolding public health emergency.*"[2]

Risk communication in a traditional understanding was following the command-and-control style of crisis response that focussed on the timely transmission of information, advice and recommendations to the public to ensure smooth operations during the time of an outbreak. The IHR (2005) introduces a broader understanding of risk communication that conceptualise risk communication throughout the lifecycle of a public health emergency (before, during and after) as multi-sectoral and multilevel process between stakeholders and the public, and aiming at gathering multiple sources of intelligence for risk assessment in order to better understand risks, engage with communities and promote resilience. Member States are obliged to build and assess their IHR core capacities.

IHR 2005 Joint External Evaluation tool (2016)

In order to facilitate and strengthen IHR (2005) capacity building, the Global Health Security Agenda (GHSA) has suggested a joint external evaluation tool (JEE 2016)[3] that compliments

[1] https://www.chathamhouse.org/sites/files/chathamhouse/events/2017-02-17-msc-roundtable-report.pdf

[2] http://apps.who.int/iris/bitstream/10665/84933/1/WHO_HSE_GCR_2013.2_eng.pdf (April 2013); Page 16.

[3] https://www.ghsagenda.org/assessments

IHR assessments and supports countries to identify strengths and weaknesses in their capacity profile. The evaluation tool outlines five outcome areas of risk communication:

- Risk communication systems (plans, mechanism, etc.),
- Internal and Partner communication and coordination,
- Public communication,
- Communication engagement with affected communities, and
- Dynamic listening and rumour management.

In the newer understanding the aim of risk communication is that: "*States Parties should have risk communication capacity which is multi-level and multi-faced, real time exchange of information, advice and opinion between experts and officials or people […] so that they can take informed decisions to mitigate the effects of the threat or hazard and take protective and preventive action. It includes a mix of communication and engagement strategies like media and social media communication, mass awareness campaigns, health promotion, social mobilization, stakeholder engagement and community engagement.*"[4]

With this broader scope, the key areas of risk communication include changes to public health practice that impact on the roles and responsibilities of public health authorities. While the focus of risk communication used to be primarily on the timely transmission of scientific information to the public during a crisis, the time period is now extended to the entire public health emergency encompassing prevention, preparedness, detection, response and recovery ("before, during and after"). The character of risk communication has also changed: from a unidirectional conveyance of scientific information and assessments, to an engaging and listening approach to communities in order to better understand communities concerns and perceptions of risks. Public health authorities are required to use multiple sources of intelligence, formal (e.g. KAP surveys) and informal (e.g. rumour), to inform their risk assessment and risk communication. In order to deliver in these new roles of risk communication, organisational changes at public health authority level are required to accommodate these changed demands and the intended impact of risk communication. The desired impact of risk communication in the understanding of WHO most recent IHR assessment is that "*responsible entities effectively communicate and actively listen and incorporate the publics' and communities' concerns through the media, social media, mass*

[4] http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf?ua=1 page 68

awareness campaigns, health promotion, social mobilization, stakeholder engagement and community engagement for increased risk awareness to reduce and mitigate the expected impact of the health hazard before, during and after public health events."[5]

Sendai Framework for Disaster Risk Reduction (2015-2030)

This new understanding of risk communication is re-iterated through the third major international framework: The Sendai Framework for Disaster Risk Reduction (2015-2030). The United Nations Office for Disaster Risk Reduction (UNISDR) has published its revised framework to reduce and mitigate risks and promote resilience that reinforces the key attributes of the changes in the understanding of risk communication. The "Sendai Framework for Disaster Risk Reduction (2015-2030)" states that disaster risk reduction builds on the collaboration between multiple sectors and an "all-of-society engagement and partnership."[6] It requires "*a coordination mechanism within and across sectors and with relevant stakeholders at all levels*."[7]

While the IHR and JEE frameworks describe the activities and outcomes of risk communication, the risk reduction approach stresses the importance of a governance structure that supports these activities, reinforces the outcome areas and underlines the crucial role of coordination mechanisms between sectors and different stakeholders.

These three international frameworks describe the changed character and purpose of risk communication: from a limited communication activity during an emergency to a governance approach that coordinates a multi-sectoral, all-of-society engagement and partnership with strategic activities in the information gathering, communication and coordination.

In accordance with these conceptual changes in risk communication, the roles and responsibilities of public health authorities have also changed: they - should - now use multiple sources of intelligence such as formal (e.g. CAP surveys) and informal (e.g. rumour) sources to inform their risk assessment, engage with communities and apply traditional and new means of communication, and collaborate proactively with other stakeholders.

In order to reflect these changes, four areas of risk communication outputs are needed:

First, it requires **research** into the new paradigm of risk communication. This evidence is

[5] http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf?ua=1 page 68
[6] http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf page 13
[7] http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf page 13

needed to inform health policy decision making;

Second, **risk communication strategy** development is necessary that goes beyond simple communication training, but supports and accompanies health authorities to find and fill their new roles and responsibilities;

Third, **evaluation** tools need to provide information about the progress of risk communication, feedback changes and pinpoint to improvement areas. They are also needed to justify spending and investment.

Fourth, **teaching and training** of this new risk communication in public health and health security is required to build the knowledge base for sustainable development and lasting progress.

2. Key concepts of risk communication

The international legislative framework of risk communication in the field of public health and health security (IHR 2005, JEE and Sendai Framework 2015-2020) demand scientific evidence, policy advice and good practice examples to inform decision-making and governance.

The key contributions to advancing research, policy and practice are structured around five thematic areas:

- Paradigm shift in risk communication,
- Strategy development at health policy level,
- Assessment score for public health security,
- Evaluation framework for public health interventions, and
- Good practice examples (Ebola and earlier detection).

Paradigm shift in risk communication

The major contributions to risk communication research are the introduction of the new paradigm of risk communication describing four distinct changes in the risk communication activities and a structured risk communication activity matrix that allows for systematic assessment and strategic planning of activities.

The publication "*Risk communication as core public health competence*"[8] in Eurosurveillance

[8] Petra Dickmann, Thomas Abraham, Satyajit Sarkar, Piotr Wysocki, Sabrina Cecconi, Franklin Apfel and Ülla-Karin Nurm (2016): Risk communication as a core public health competence in infectious disease management:

2016 outlines risk communication as a core competence in public health and presents the changes in the understanding of risk communication that leads to a different practice of risk communication. This publication is innovative in two regards: it introduces a coherent, systematic approach to the new paradigm of risk communication; and it applies this new paradigm to a teaching and training methodology.

The new risk communication paradigm thus sees risk communication in a more complex approach as a governance approach with strategic activity areas of information (gathering, assessing and sharing), communication (strategies, key messages and means of communication) and coordination (at various administrative levels).
The four key changes and characteristics of the new paradigm are:
1. From telling to ***listening*****:** Risk communication is viewed as a complex process. It is as concerned with listening and understanding as it is with providing information and advice.
2. From information transfer to ***relationship building:*** Risk communication is not seen as exclusively based on information transmission, but as a strategic activity concerned with relationship building between authorities and the public over time.
3. From "command and control" to ***creating supportive environments:*** Risk communication is not just about directive action, but is concerned with creating supportive environments where people can make their own informed decisions.
4. *From silo'ed to* ***coordinated approaches***: Multiple actors and sectors are inevitably involved with all risk communication related issues. Risk communication is concerned with integration and partnership.

Applying these changes to a systematic approach of risk communication practice, this paper introduces a matrix of risk communication activities across the lifecycle of a public health event.

Risk communication activities	**BEFORE** **Public health emergency** **PREPAREDNESS**	**DURING** **Public health emergency** **RESPONSE**	**AFTER** **Public health emergency** **LEGACY**

development of the ECDC training curriculum and programme, Eurosurveillance 2016; 21(16); pii=30188, DOI: dx.doi.org/10.2807/1560-7917.ES.2016.21.14.30188

Information *Listening*	**Gathering**			
	Assessing			
	Sharing			
Communication *Relationship building*	**Communications (actions: flyer, website, etc.)**		Crisis communication	
	Key messages / Content			
	Strategy / Methods			
Coordination *Supportive environments*	**Local**			
	Regional			
	National			
	International			

Figure 1: Matrix of risk communication[8]

The training approach that was piloted at the European Centre for Disease Control and Prevention (ECDC) is built on this new paradigm of risk communication both in the topics addressed and in the methods applied.

The new risk communication training extended the scope of risk communication to activities before, during and after public health events. Moving risk communication away from responses during a crisis, case studies of continuous infectious diseases challenges, e.g. antimicrobial resistance, vaccine hesitancy, etc., were used. The narrative of risk communication has more to do with knowledge- and relationship building than simple information conveyance. The training adopted a deconstructive approach and facilitated a look at the discourses that shape people's decisions and behaviour. The pilot also put an emphasis on interactive, critical and reflective processes in groups. Rather than listening to lectures, a structured, moderated hands-on approach was utilised that engaged with participants and facilitates active learning, understanding and networking. The training aimed to help participants to *understand* the concepts that underlie risk communication advice before they are able to really implement "good advice" on risk communication strategies into their own realities. It is not enough to follow a set protocol with practical risk communication advice (e.g. be honest, communicate early, etc.). Once underlying risk communication concepts are understood and internalised, appropriate practical activities follow in an easy and intuitive way. Thus the training adopted

a reflective approach. Rather than emphasising detailed guidance that lists the steps to go from A to B, the training took a reflective approach that aimed to provide participants with a map, the skill and literacy to read the map and the ability to design their own risk communication strategies that work in their realities.
This pilot training approach was evaluated and participants rated the training topics and methodology highly.

The second publication that contributes to the advance of evidence in the field of risk communication in public health, is an analysis of a public health authority helpdesk answering questions in regards to antimicrobial resistance (AMR) and Meticillin-resistant *Staphylococcus aureus* (MRSA), in particular. The analysis "*Re-thinking risk communication: information needs of patients, health professionals and the public regarding MRSA - the communicative behaviour of a public health network in Germany responding to the demand for information*"[9] stresses the role of public health authorities as major actors in the field of risk communication and reflects the relation between information and communication. This analysis found that while helpdesk response surely offered scientific advice, they also included "other communication services that went beyond the provision of scientific facts, such as follow up calls, referral suggestions and consultations on behalf of the caller". The article concludes that "these social communication activities seem to have an important impact on the acceptability of public health recommendations and use of the helpdesk." This mixed-method analysis supports the paradigm of risk communication in regards to the activities of public health professionals that are part of the risk communication process, moving its core activity from conveying information and communicating risk information to being a knot in the social fabric of a health system, concerned with relationship building and listening.

Also concerned with MRSA and risk communication is the final contribution to this chapter of paradigm shift in risk communication. The article "*Risk communication of antimicrobial resistance: The Role of Clinical Practice, Regulation and Other Policies in Five European*

[9] Petra Dickmann, Katharina Wittgens, Sam Keeping, Dorothea Mischler and Ursel Heudorf (2015): Re-thinking risk communication: information needs of patients, health professionals and the public regarding MRSA - the communicative behaviour of a public health network in Germany responding to the demand for information. Public Health 12/2015.

Countries in regards to MRSA"[10] has two important contributions to the discourse about risk communication practice in public health: first, it introduces regulations and guidelines "as implicit messages that contribute to the health-related risk communication and subsequently to the public perception of risk posed by MRSA." The diversity and inconsistency of these implicit messages that contribute to the explicit risk communication messages are an underestimated and under reflected area of risk communication. Second, it disentangles and deconstructs a public health policy approach that puts responsibility for global public threats from health policy to individual behaviour advice. Singling out individuals, or even reducing the complex problem of AMR to hand washing, is probably a useful strategy to delegate responsibility, but it does not contribute to a constructive and sustainable way to tackle one of the most important questions for infectious diseases in the 21st century.

The implications of the new risk communication paradigm in the traditional field of infectious diseases (e.g. MRSA) and public health authorities are

- A novel perspective to analyse and understand policy and practice,
- Additional scientific evidence to a body of research,
- A structured and systematic approach to risk communication activities, that enable
- Assessment and evaluation of the role of public health professionals.

Strategy development at health policy level

The broader understanding of risk communication moves beyond a common understanding that limits risk communication to a timely conveyance of information about health risks to a public. It considers risk communication not as a technical expertise in communication but rather as a strategic activity supporting the entire management of public health risks. This transformation process, thus, requires from national public health agencies to re-think their current risk communication strategies and plans. Addressing this new challenge, national public health agencies have little guidance in developing their national risk communication strategies and creating a modern risk communication governance. While there is existing guidance on the communication process and on what health authorities need to consider to

[10] Petra Dickmann, Sam Keeping, Nora Döring, Andrea E Schmidt, Claudia Binder, Sergio Ariño-Blasco and Joan Gil(2017): Communicating the Risk of MRSA: The Role of Clinical Practice, Regulation and Other Policies in Five European Countries. Front. Public Health 5:44. doi: 10.3389/fpubh.2017.00044

design communication strategies, little is done to support strategy development at governance level.

The major contribution of the publication "*Biological risks to public health – lessons from an international conference to inform the development of national risk communication strategies. Report of an international conference on risk communication strategies before, during and after public health emergencies*"[11] is to provide a multi-sectoral platform for international discussions and a systematic approach to develop risk communication strategies at national public health authority level.

Using the risk communication activity matrix (s. figure 1) the discussions were structured into an overall governance approach with the strategic areas of information (gathering, assessing and sharing), communication (strategies, key messages and means of communication) and coordination (at various administrative levels). Risk communication is not merely a technical capacity, but a governance approach that enables broader practice and improvements of technical areas. In order to accommodate this new paradigm of risk communication, organisations need to identify and promote changes to enable this risk governance approach.

The discussion concluded four key areas of improvements in risk communication: consider communication as a multidimensional process in risk communication, broaden the biomedical paradigm by integrating social science (and other source of) intelligence into epidemiological risk assessments, strengthen multi-sectoral collaboration including local organisations, and spearhead changes in own organisations for better risk communication governance.

National strategies should design risk communication to be proactive, participatory, multi-sectoral, facilitating the connection between sectors and strengthening collaboration.

The results of this international discussion informed the development of national risk communication strategies in North Africa (Morocco and Tunisia).

Assessment score for public health security

Biological risks pose challenges to public health. These risks can be naturally occurring disease outbreaks at national and international levels, accidental exposure to pathogens in the context of biomedical diagnostics and research or intentional use of pathogens for harmful purposes. Biological risk management focuses on these following three areas of:

[11] Petra Dickmann, Aphaluck Bhatiasevi, Fadela Chaib, Ombretta Baggio, Christina Banluta, Lilian Hollenweger and Abderrahmane Maaroufi (2016): Biological risks to public health - lessons from an international conference to inform the development of risk communication strategies. Health Security 14(6):433-440.

i) The preparedness for the impact of naturally occurring disease outbreaks on national or international scale on individual and public health, national and international economy, social and other systems;

ii) *Biosafety* as understood by the UN as "*principles, technologies, practices and measures implemented to prevent the accidental release of, or unintentional exposure to pathogenic agents*."[12]

iii) *Biosecurity* which refers to the "*protection, control and accountability measures implemented to prevent the loss, theft, misuse, diversion or intentional release of pathogenic agents and related resources as well as unauthorized access to, retention or transfer of such material*."[12]

The World Health Organization has recognised the importance of biological risks to public health and has updated its International Health Regulations (IHR) in 2005 to ensure that all member states build their capacities to prevent, detect, respond to and recover from biological and other defined risks to public health and ensure to minimise the impact on trade and travel (IHR 2005). Public health authorities have worked on technical areas to mitigate biological risks, such as improving disease surveillance systems, laboratory capacities, risk assessment and risk communication. However, biosafety and biosecurity concepts are complex (as is risk communication), lack standardisation, and are often understood differently by scientific and security experts, policy-makers and the public. To address this challenge, the publication "*The Marburg Biosafety and Biosecurity Scale (MBBS): A framework for risk assessment and risk communication*"[13] provides a clear and systematic classification of risk assessment categories, a discreet metric for biosafety and biosecurity and rational framework to facilitate risk communication. Similar to the Richter-scale to assess and communicate the severity of earthquakes, the MBBScale provides a rational score and visual chart to assess and communicate biosafety and biosecurity threats (figure 2).

The MBBScale draws on the concept of the International Nuclear Event Scale (INES) and evaluates the impact of laboratory-originated incidents on three categories: personnel, integrity of containment (in this context: biocontainment) and the environment. It describes a new seven

[12] Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, Report of the meeting of states parties. Geneva 2008 Contract No.: BWC/MSP/2008/5.

[13] Petra Dickmann, Franklin Apfel, Nadine Biedenkopf, Markus Eickmann and Stephan Becker (2015): Marburg Biosafety and Biosecurity Scale (MBBS) – a framework for risk assessment and risk communication, Health Security 03/2015, 2(13): 88-95.

category scoring scale of biosafety and biosecurity threats that helps clarify risks, facilitate coordination and communication and improve public understanding of risk related to biosafety and biosecurity.

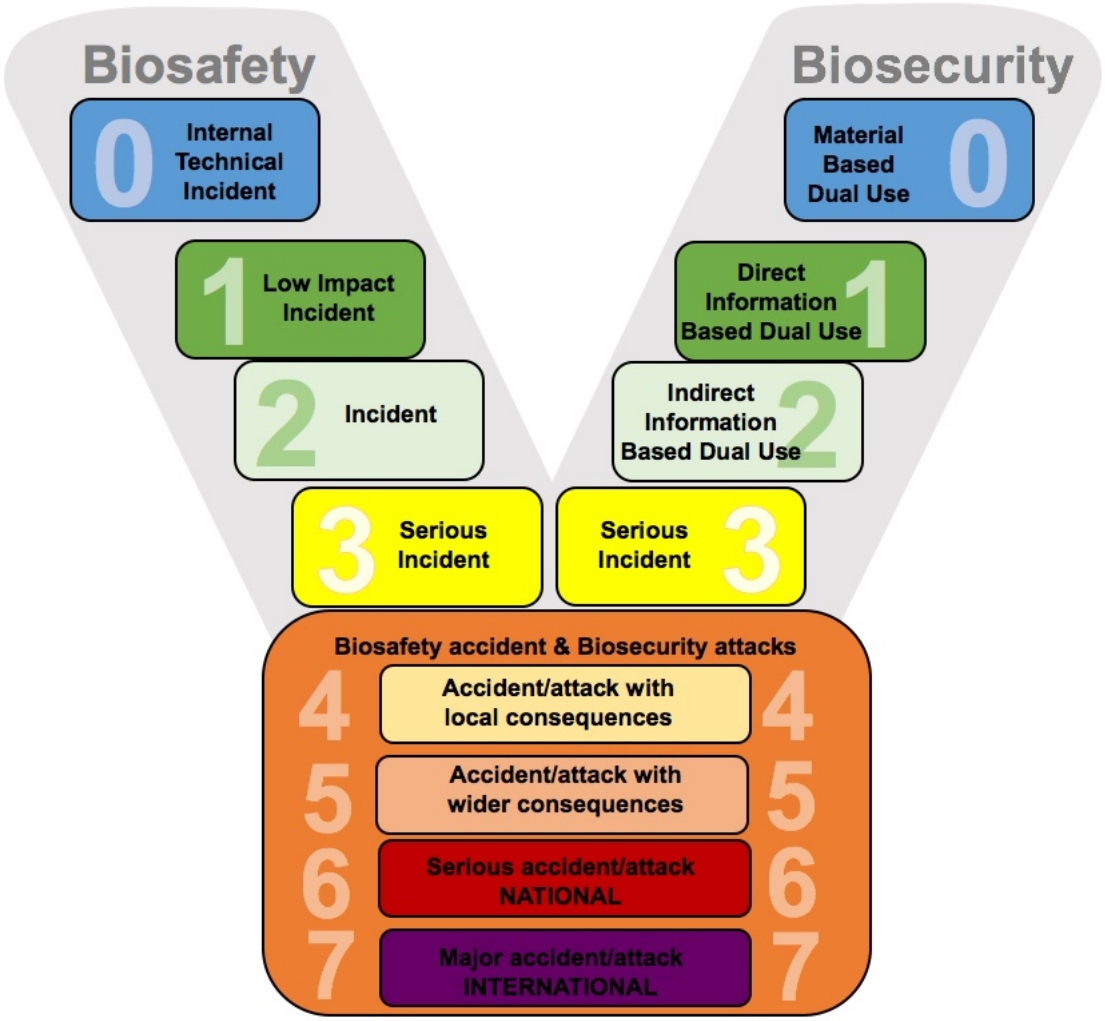

Figure 2: Y-shape of biosafety and biosecurity scale[13]

A second major contribution to the public health security is a framework for biosafety and biosecurity capacity building: "Local – People – Make Sense: Biosafety and Biosecurity. A relative risk-based framework for safer, more secure and sustainable laboratory capacity building".[14] This publication is important in two regards: it provides a novel framework that can guide capacity building in biosafety and biosecurity (content level); it also applies a new

[14] Petra Dickmann, Heather Sheeley and Nigel Lightfoot (2015) Biosafety and biosecurity: a relative risk-based framework for safer, more secure, and sustainable laboratory capacity building. Front. Public Health 3:241. doi: 10.3389/fpubh.2015.00241

and innovative methodology to use a structured and facilitated group dynamic to generate evidence (methodological level).

Laboratory capacity building is characterized by a paradox between endemicity and resources: Countries with high endemicity of pathogenic agents often have low and intermittent resources (water, electricity) and capacities (laboratories, trained staff, adequate regulations). Meanwhile, countries with low endemicity of pathogenic agents often have high containment facilities with costly infrastructure and maintenance governed by regulations. To ensure the safe and secure handling of pathogenic agents the current practice is mainly focussed on exporting the complex costly containment, 'western standard' of laboratory safety into vulnerable areas of the world with high demand for laboratory activity due to emergency outbreak situations or a continuous high prevalence. This practice has not always been effective to date, needed investments have not been fully sustainable, the 'western standard' of biosafety relies on adequate and continuous access to resources and educated personnel.

The Global Health Security Agenda (GHSA) points to a lack of collaboration and integration of health and security approaches and communities and thus calls to end the silo-thinking and encourages an integrated health security approach.

The publication introduces a generic framework that is guided by the phrase 'LOCAL – PEOPLE – MAKE SENSE' that represents three major principles: capacity building according to local needs (local) with an emphasis on relationship and trust-building (people) and continuous outcome and impact measurement (make sense). The framework applies a relative-risk approach: The relative-risk approach focuses on conditions of biosafety and biosecurity that can make work safer, more secure and sustainable in specific environments. To this end, the approach builds on a *contextual assessment of risks* and considers the system and environments (e.g., information, communication and coordination systems) in which laboratory capacity is being built. This differential approach reflects and relates 'inside' of the laboratory with 'outside' the laboratory and considers the permeability of the barrier separating them. This approach focuses on the barrier that separates the inside from the outside and provides a structured assessment of the relative risks. Rather than defining the endpoint as adherence to Western standards, it focuses on agreed outcomes (e.g. maintaining the biocontainment barrier) and develops contextually appropriate, relevant parameters for biosafety and biosecurity. This generic framework could guide international policy decision-making to build safer, more secure and sustainable laboratory capacity.

The methodology to create and design the framework draws on the risk communication

paradigm. The two-day workshop to create the framework was based on interactive, interdisciplinary work in small groups of people coming from different professional backgrounds (biomedical, sciences, engineering and policy-making) with experience from both fields of biosafety and biosecurity in low-, mid- and high-resource settings. The workshop applied group work that was structured to trigger dialogue and debate on current practices, stimulate thinking about what changes could lead to safer, more secure and sustainable laboratory capacity-building (particularly in low-income countries), and capture participants' insights on the specific components, attributes and principles of such changes. In the group work, participants used analytical tools and templates building on the matrix of risk communication governance and its strategic areas of information (gathering, assessing, sharing), communication (strategies, key messages and means of communication) and coordination (at various administrative levels) to analyse the contradictions, contrasts and issues and presented their results in plenary sessions for broader discussion. They further reflected on conditions and influencing factors and developed actions to strengthen facilitating factors for biosafety and biosecurity.

Evaluation framework for public health interventions

Evaluation of public health interventions is essential to monitor progress, identify and assess areas for improvements and demonstrate useful outcomes and overall impact. Researchers have used before and after measures, various models and data sources to estimate how much difference in awareness, choice and behavioural patterns, a given risk communication intervention has made for a particular outbreak. These measurements have been built on approaches to risk communication that mainly focussed on the need to find the right way to tell people what to do in times of a crisis. Such approaches are important, but do not reflect current thinking and concerns about the limitations of just focussing on uni-directional, hierarchical information conveyance from health officials to the public. Risk communication as described in a new paradigm is now understood as a more interactive, holistic, continuous and engaging activity that focuses on dialogue, intelligence gathering, building relationships over time, a knowledge base informed by new and accessible communication technologies (e.g., social media and networks), and supportive environments. However, while the importance of risk communication in public health interventions is increasingly acknowledged and embraced e.g. as a core capacity in the WHO IHR 2005, no standardised measurement tools have been agreed to evaluate the impact of risk communication activities upon unfolding infectious disease emergencies and continuous threats.

The publication "*Making sense of communication interventions in public health emergencies – an evaluation framework for risk communication*"[15] is the result of an international, inter-agency collaboration (WHO, International Federation of the Red Cross and Red Crescent, Unicef) with risk communication experts, born from the demand and urgent need to better understand how risk communication interventions make or can make a difference.

This publication introduces a new and innovative evaluation framework for risk communication. It uses the dynamic of an event (such as an outbreak) and the dynamic of response interventions, e.g. a public health authority. Relating these two dynamics, the framework identifies four key performance areas where risk communication activities can improve the situation:

- EARLIER detection (1): reducing the time lag between onset of outbreak and its detection by getting closer to and more engaged with the community and the infectious activities on the ground
- FASTER response (2): reducing the time lag between detection and response activities
- SMOOTHER coordination (3): better coordination of national and international response activities
- SMARTER legacy and governance (4): feeding back to improve decision-making and response in the current event and leaving a legacy to improve preparedness, control, response and recovery for future outbreaks

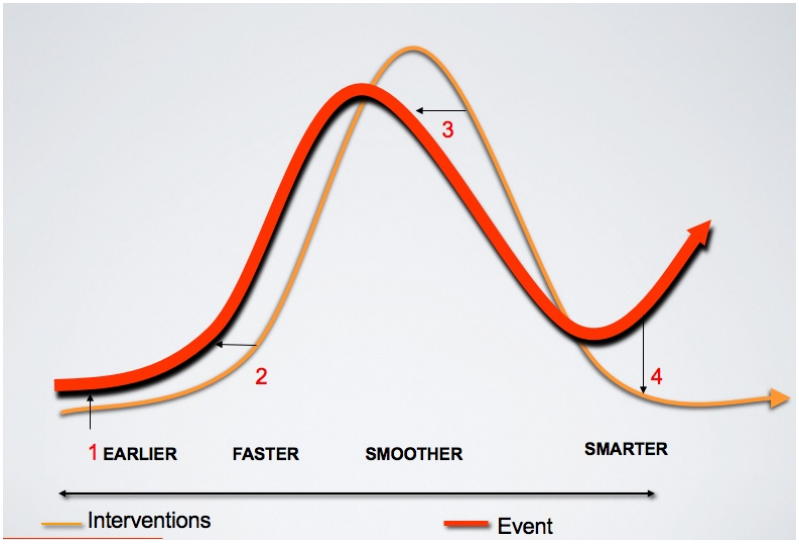

Figure 3: Earlier – Faster – Smoother – Smarter Approach[15]

[15] Petra Dickmann, Amanda McClelland, Gaya M Gamhewage, Patricia Portela de Souza, Franklin Apfel (2015): Making sense of communication interventions in public health emergencies - an evaluation framework for risk communication. Journal of Communication in Healthcare 2015; 8(3), 233-240. DOI: 10.1080/17538068.2015.1101962

Applying the risk communication activity matrix that conceptualises risk communication as a governance approach with its three strategic axes of information (gathering, assessing, sharing), communication (strategies, key messages and means of communication) and coordination (at various administrative levels), the evaluation process can map and monitor activities according this systematic approach; it can also identify areas for improvements.

This evaluation framework is an original and innovative contribution to the current thinking of risk communication, its measurement and evaluation.

In order to test the evaluation framework, two case studies have been published so far: one reporting the results of the risk communication methodology to improve preparedness, detection of, response to and recovery from Ebola virus outbreak in West Africa; two, a systematic investigation into conditions and influencing factors for earlier detection in low- and mid-income countries.

Case studies

International activities to respond to the Ebola crisis in West Africa (2015-16) were mainly focussed around the biomedical paradigm of western health systems. This approach clashed with community-based health narratives, the social fabric of communities and the role of community health workers.

The publication "*Using lessons learned from previous Ebola outbreaks to inform current risk management*"[16] systematically gathered and collated local experience, knowledge and intelligence to improve the risk communication and management approach. The outputs of this meeting were three major lessons that focus on improving communication, working with communities, and building and strengthening local capacity. However, apart from the thematic contributions to solve a current global problem, the methodology to gather, assess, analyse and reflect on past experience, together with a systematic approach to create and generate recommendations was a particular milestone in the conceptual landscape of risk communication. The workshop was designed for 'shapers': a mixed audience of health professionals, community leaders, journalists, policy-makers, religious leaders, traditional

[16] Petra Dickmann, Andrew Kitua, Paul Kaczmarek, Julius Lutwama, Justin Masumu, Esron Karimuribo et al. (2015): Using Lessons learned from previous Ebola outbreaks to inform current risk management. Emerging Infectious Diseases 05/2015, 21(5): DOI: 10.3201/eid2105.142016

healers and media representatives from eastern and central Africa who shape the narrative of infectious disease management, risk communication and community outreach in their countries. Participants from these various backgrounds worked in facilitated small interactive groups using analytical tools to elicit the underlying assumptions, perceptions and beliefs of infection control management in their countries with the aim to shift the agenda and the narrative to people-centred medicine and a community-based health paradigm.
As in previous workshops, the particular incubator approach was applied – at a methodological level - that provides a logical flow through a serious of group work sessions that are themselves structured with matrixes and templates. This systematic approach allowed to reflect "outside the box" of conventional knowledge gathering, because it enables participants to challenge their own conceptions and beliefs and disrupts their own logic ("deconstruction"); building on this deconstruction, participants can then re-assemble innovative, new solutions that are locally informed and relevant for their particular contexts.

The workshop methodology was further applied in an "Ebola – Intensified Preparedness Programme (IPP)" that was conducted in Ebola-affected and not-yet affected countries, and other settings. This methodology will soon be published.

A second example of the application of the novel risk communication methodology is an investigation into conditions and influencing factors of earlier detection. The publication "*Drivers for earlier detection. A systematic literature review*"[17] provides a structured overview of systems and guidance to detect health events earlier. Infectious disease outbreaks can spread rapidly, causing enormous losses to individual health, national economies, and social wellbeing. Through early detection of an infectious disease outbreak, a small outbreak can potentially be contained at the local level, thereby reducing adverse impacts. The ambition is to better understand what conditions and factors of a health system can lead to detect outbreaks/events earlier. This systematic literature review applies the traditional PRISMA methodology and it reveals that despite significant investments to detect outbreaks early, there is very little evidence with respect to factors that influence earlier detection.
This publication is the initial step into a field of research into conditions and their influencing factors that can modify detection time, and potentially quality. The innovative and original

[17] Lindsay Stelle, Emma Orefuwa and Petra Dickmann (2016): Drivers of Earlier Infectious Disease Outbreak Detection: A systematic literature review. International Journal of Infectious Disease 53:15-20.

aspect of this review is the introduction of a generic disease/event detection model that can be applied in a variety of settings. This generic model provides a systematic structure to sort evidence. Infectious disease surveillance follows a multi-level public health model, where a case or an event first must be recognised as unusual, and then reported and assessed (as a signal). If the case or event meets criteria for further notification, it is reported to higher level authorities and subsequent assessment/investigation ensues. This detection process can be categorised into the following five generic steps: 1) Recognition (of a case or an event); 2) Low level reporting; 3) Low level assessment; 4) Higher level reporting; and 5) Higher level assessment (when outbreak declaration occurs). While the key players involved at each step will vary by region/country and disease, the basic structure is the same.

This generic disease/event detection model and the new risk communication methodology are further applied in data generation in low- and mid-income countries. The results of this research will be published soon.

3. Perspective

Current and future activities in the field of risk communication in public health and health security can be summarised into three main categories:

First, at a thematic level, they are relevant outputs how to improve and enrich risk communication research, policy and practice in the four key performance areas, such as

- Earlier detection, e.g. in infectious diseases prevention and control, non-communicable disease detection, biosecurity health risks, etc.;
- Faster response, e.g. identifying factors at health system level that are particularly relevant for a speedy response;
- Smoother coordination, e.g. by supporting and providing evidence for risk communication as core capacity in international legislative frameworks;
- Smarter legacy, e.g. by enabling systematic reflection and learning from past events to inform current and future policy and governance approaches.

Second, at a methodological level: the conventional approach uses quantitative, qualitative and mixed-method approaches to generate data and insight. While those are primarily at individual (or sums of individuals) or population level, the intelligence of groups is not well integrated into this evidence making process. The incubator workshop approach that was applied in a variety of settings so far, has resulted in original and innovative solutions; this approach uses

the dynamics of different groups (over a set time period) working together in a systematically structured and facilitated environment. The incubator workshop is one format of the social laboratories to systematically develop new and better solutions using the dynamic and intelligence of groups. Social laboratories offer a platform for extended investigations that are

- Social by bringing different people from various backgrounds together;
- Experimental by focusing on a question and applying a structured methodology for analysing ideas and creating interventions over a set time period and other controlled conditions; and
- Systematic by applying a structured, analytic approach using objective templates and matrices.

This approach has the potential to become a genuine methodological category.

Third, the recent developments in policy, legislation and practice require people and professionals who are able and competent to deliver in these new roles and responsibilities of public health and health security in a complex world. Modern teaching and sustainable training are ideally set in a structured and supportive environment, such as a degree course in public health from a multi-sectoral, One Health perspective, for long-lasting implementation of competence and capacities, skills and expertise.

References

[1] https://www.chathamhouse.org/sites/files/chathamhouse/events/2017-02-17-msc-roundtable-report.pdf

[2] http://apps.who.int/iris/bitstream/10665/84933/1/WHO_HSE_GCR_2013.2_eng.pdf (April 2013); Page 16.

[3] https://www.ghsagenda.org/assessments

[4] http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf?ua=1 page 68

[5] http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf?ua=1 page 68

[6] http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf page 13

[7] http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf page 13

[8] Petra Dickmann, Thomas Abraham, Satyajit Sarkar, Piotr Wysocki, Sabrina Cecconi, Franklin Apfel and Ülla-Karin Nurm (2016): Risk communication as a core public health competence in infectious disease management: development of the ECDC training curriculum and programme, Eurosurveillance 2016; 21(16); pii=30188, DOI: dx.doi.org/10.2807/1560-7917.ES.2016.21.14.30188

[9] Petra Dickmann, Katharina Wittgens, Sam Keeping, Dorothea Mischler and Ursel Heudorf (2015): Re-thinking risk communication: information needs of patients, health professionals and the public regarding MRSA - the communicative behaviour of a public health network in Germany responding to the demand for information. Public Health 12/2015.

[10] Petra Dickmann, Sam Keeping, Nora Döring, Andrea E Schmidt, Claudia Binder, Sergio Ariño-Blasco and Joan Gil(2017): Communicating the Risk of MRSA: The Role of Clinical Practice, Regulation and Other Policies in Five European Countries. Front. Public Health 5:44. doi: 10.3389/fpubh.2017.00044

11 Petra Dickmann, Aphaluck Bhatiasevi, Fadela Chaib, Ombretta Baggio, Christina Banluta, Lilian Hollenweger and Abderrahmane Maaroufi (2016): Biological risks to public health - lessons from an international conference to inform the development of risk communication strategies. Health Security 14(6):433-440.

[12] Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, Report of the meeting of states parties. Geneva 2008 Contract No.: BWC/MSP/2008/5.

[13] Petra Dickmann, Franklin Apfel, Nadine Biedenkopf, Markus Eickmann and Stephan Becker (2015): Marburg Biosafety and Biosecurity Scale (MBBS) – a framework for risk assessment and risk communication, Health Security 03/2015, 2(13): 88-95.

[14] Petra Dickmann, Heather Sheeley and Nigel Lightfoot (2015) Biosafety and biosecurity: a relative risk-based framework for safer, more secure, and sustainable laboratory capacity building. Front. Public Health 3:241. doi: 10.3389/fpubh.2015.00241

[15] Petra Dickmann, Amanda McClelland, Gaya M Gamhewage, Patricia Portela de Souza, Franklin Apfel (2015): Making sense of communication interventions in public health emergencies - an evaluation framework for risk communication. Journal of Communication in Healthcare 2015; 8(3), 233-240. DOI: 10.1080/17538068.2015.1101962

[16] Petra Dickmann, Andrew Kitua, Paul Kaczmarek, Julius Lutwama, Justin Masumu, Esron Karimuribo et al. (2015): Using Lessons learned from previous Ebola outbreaks to inform current risk management. Emerging Infectious Diseases 05/2015, 21(5): DOI: 10.3201/eid2105.142016

[17] Lindsay Stelle, Emma Orefuwa and Petra Dickmann (2016): Drivers of Earlier Infectious Disease Outbreak Detection: A systematic literature review. International Journal of Infectious Disease 53:15-20.

II. Paradigm shift in risk communication

1. RISK COMMUNICATION AS A CORE PUBLIC HEALTH COMPETENCE IN INFECTIOUS DISEASE MANAGEMENT: Developing the ECDC training curriculum and programme[18]

Abstract

Risk communication has been identified as a core competence for guiding public health responses to infectious disease threats. The IHR (2005) calls for all countries to build capacity and a comprehensive understanding of health risks before a public health emergency to allow systematic and coherent communication, response and management. Research studies indicate that while outbreak and crisis communication concepts and tools have long been on the agenda of public health officials, there still exists an expressed need to clarify and integrate risk communication concepts into more standardised practices and improve risk communication and health, particularly among disadvantaged populations.

To address these challenges, the European Centre for Disease Prevention and Control (ECDC) convened a group of risk communication experts to review and integrate existing approaches and emerging concepts in the development of a training curriculum. This process articulated a new approach which breaks with the conventional understanding and practice of communication as a conveyance of information and understands risk communication as having more to do with knowledge- and relationship-building.

In a pilot training this conceptual approach was reflected both in the topics addressed and in the methods applied. Rather than working exclusively on outbreak scenarios and early communication to prepare for health crises, the course put an emphasis on addressing continuous infectious risk communication challenges e.g. antimicrobial resistance and vaccination.

This article introduces the new conceptual approach to risk communication capacity building that emerged from this process, presents the pilot training approach developed, and shares the results of the course evaluation.

---

18 Petra Dickmann, Thomas Abraham, Satyajit Sarkar, Piotr Wysocki, Sabrina Cecconi, Franklin Apfel and Ülla-Karin Nurm (2016): Risk communication as a core public health competence in infectious disease management: development of the ECDC training curriculum and programme, Eurosurveillance 2016; 21(16); pii=30188, DOI: dx.doi.org/10.2807/1560-7917.ES.2016.21.14.30188
REPRINT WITH GENEROUS PERMISSION OF EUROSURVEILLANCE.

Keywords
Risk communication, Vaccination, Immunisation, Infectious Disease, Communicable Disease Prevention

Introduction

The International Health Regulations (IHR 2005) have been developed to help all countries better prepare and respond to public health emergencies of international concerns. The importance of risk communication is recognised as one of the eight core capacities in the successful management of infectious diseases and other public health risks both in terms of gathering intelligence, and in enabling the functional flow of information, communication and coordination [1]. During a public health emergency time is short and important information, communication and coordination tasks such as identifying public communication focal points and stakeholders, developing and implementing reliable communication structures, etc. should be in place to allow systematic and coherent crisis communication and management [2].
Risk communication is understood in this context as serving a double role: risk communication should prepare for crisis management; and it should build capacity and a comprehensive understanding of health risks among health officials and the general public. This capacity building is needed for peaks in demand and public health emergencies, but also for managing continuous health threats, such as outbreaks of measles (due to low coverage or uptake of vaccines) or the emergence of antimicrobial resistance (due to overuse or misuse of antibiotics). Poor risk communication can even cause harm [2].
Research studies indicate that while outbreak and crisis communication concepts and tools have long been on the agenda of public health officials, there is a need to better address risk communication concepts and practices and integrate conceptual approaches into sound practice and improve risk communication and health, in particular for disadvantaged populations and to those areas with low confidence in vaccines [3,4].

Currently, there is little consensus about the meaning, impact and methods of risk communication in infectious disease contexts. Risk communication as a technical term emerged during the early 1970 in the environmental health debates and has since then spread into different disciplines and discourses [5,6]. The understanding of risk communication as "*information exchange about health risks caused by environment, industrial, or agricultural, processes, policies, or products among individuals, groups and institutions*" [6] has become more prominent post September 11, 2001. The conceptual foundations of risk communication

draw on complex social, cognitive and psychological research elaborated in a wide variety of areas; including: behavioural communications, environmental health, health promotion, governance and social marketing [6]. The public health practice of risk communication, however, has been slow to embrace such a broader perspective and has been mainly focussed on approaches that rationalise and work to improve risk communication as the communication of risks from public health authorities to their publics [7,8].

Efforts to broaden this approach to risk communication to implementation in the field in public health practice face three substantial challenges:

Firstly, it is not known how it is to be done ("you don't know because no one knows"). While there is a plethora of practical guidelines, best-practice examples and ad-hoc advice (e.g. WHO outbreaks communications [9], CERC [10], etc.), this advice is mainly orientated towards communicating risks in outbreak and crisis situations [11]. While there is a multiplicity of conceptual approaches to risk perception and communication, e.g. Slovic [12,13], Fischhoff/Morgan [14,15], Kasperson [16], there is little integration of these approaches into risk communication in public health practice.

Secondly, there is a lack of individual skills ("you don't know how to do it"): there is lack of formal training and practical experience is scarce as the approach has not found entrance into mainstream public health academia and learning [17].

Thirdly, there is a lack of supportive environments: even though risk communication has been designated as a core IHR capacity, it has yet to be routinely implemented into public health organization planning, their risk assessment, and management procedures [18].

Acknowledging these challenges, the European Centre for Disease Prevention and Control (ECDC) has initiated the development of a training curriculum and programme to address the need for both conceptual and practical capacity building in risk communication as an integral component of disease prevention and control. To this end, ECDC invited practitioners and researchers on the forefront of risk communication practise to develop a new conceptual approach to capacity building and develop a teaching curriculum. The initial focus of the training was on vaccine preventable diseases, in particular enhancing measles vaccination uptake, and was first tested with ECDC experts in January 2013.

Methods

Concept review, integration and development

Working definitions

Risk and crisis communication differ in many aspects and there is terminological and epistemological ambiguity in international fora and discussions regarding definitions and approaches [19]. As a working definition we use *time*, *method* and *content* to distinguish between risk communication and crisis communication. Risk communication differs from crisis communication as risk communication starts before crisis and continuous throughout and after a crisis, is less directive, has more time to explain even difficult and contradicting scientific positions. It also has the time and opportunity to offer diverse approaches to bridge the gap between the scientific assessment of health risks and public perceptions of health risks. The main activity areas of risk communication are information (gathering, sharing and assessing), communication (strategy, key messages and communications) and coordination (on different geographical and organisations levels (see figure 1).

Crisis communication is the communication during an outbreak when people need to know exactly what to do if they are affected and how to protect themselves and others. Effective information is vital to prevent surges of low risk patients blocking medical infrastructures and to prevent the further transmission of the disease by enabling people to adopt the right behaviours. During an outbreak, time is short and crisis communication therefore needs to be concise and often unidirectional. Figure 1 displays the main activity areas of risk communication and helps clarify the distinction between working definitions of risk communication and crisis communications (see figure 1). Risk communication includes all the activities listed before, during and after a public health emergency. Crisis communication is confined to the communication during an emergency.

Risk communication activities		**BEFORE Public health emergency** **PREPAREDNESS**	**DURING Public health emergency** **RESPONSE**	**AFTER Public health emergency** **LEGACY**
Information	**Gathering**			
	Assessing			
	Sharing			
Communication	**Communications (actions: flyer, website, etc.)**		Crisis communication	
	Key messages / Content			
	Strategy /			

	Methods			
Coordination	**Local**			
	Regional			
	National			
	International			

Figure 1: Matrix of risk communication

Conceptual Approach: Communication Models

In its conventional understanding, risk communication is often focused on finding the right way to tell people what to do in times of a crisis. While this objective is important, it is not sufficient. Risk communication is goes beyond communications of risks. It is also about building public health capacity to enable, encourage and empower different publics to understand and act upon health risks [20-21] Yet, public health officials often see their tasks as just providing information. They tend to rely mainly on an early, and by now outdated information technology paradigm that assumes a rather static and unilateral sender who conveys messages to addressable recipients [22]. The reality of communication and information though has already been transformed. The public is no longer and maybe never has been a passive entity to be given recommendations and guidelines to follow by institutions which are to be trusted. This technocratic communication model (sender-message-recipient) is successful in explaining how computers communicate (with each other) – but is insufficient when it comes to understanding how humans process information, communicate and make behavioural decisions. The popularity and increasingly important intelligence gathering and information dissemination functions of interactive social media, e.g. Facebook, Twitter, LinkedIn, is a strong indicator of the growing influence of de-centralised and user-generated connectivity in today's rapidly changing communication marketplaces [23].

A new approach for risk communication in public health

In contrast to this conventional risk communication approach in public health, a new risk communication concept for public health is proposed. This builds on inputs from a variety of disciplines and applies a reflective approach. This new conceptual approach calls for four key strategic shifts in our thinking and approach to risk communication:

1. From telling to ***listening*****:** Risk communication is viewed as a complex process. It is as concerned with listening and understanding as it is with providing information and advice. Having listened and understood peoples' different perceptions and behaviours allows for quicker and more effective communication when time is short. Much can be learned in this

area from behavioural communications approaches; which, for example, emphasise listening and gathering insights about what really motivates and moves the people to whom you are trying to communicate [24].

2. From information transfer to ***relationship building:*** Risk communication is not seen as exclusively based on information transmission, but as a strategic activity concerned with relationship building between authorities and the public over time [25]. Engaging affected populations early in development, planning, on going monitoring and evaluation enhances peoples' sense of empowerment and ownership. Much can be learned in this area from social marketing approaches; which, for example, emphasise the importance of "exchange theory"- really trying to understand the benefits and rewards for a given behaviour [26,27].

3. From "command and control" to ***creating supportive environments:*** Risk communication is not just about directive action, but is concerned with creating supportive environments where people can make their own informed decisions. Much can be learned in this area from health promotion approaches; which, for example emphasises to importance of "environmental" factors on behaviour and the need "to make the healthy choice the easy choice." [28]

4. *From silo'ed to* ***coordinated approaches***: Multiple actors and sectors are inevitably involved with all risk communication related issues. Busy "loud" information marketplaces can be hard to navigate with often conflicting messages. No one agency can do it alone. Risk communication is concerned with integration and partnership. Much can be learned in this area from new governance approaches; which, for example, emphasise whole-of-government and whole-of-society approaches [29,30].

Results

Pilot training

Conceptual approach to training curriculum: methods and contents

This conceptual re-framing was reflected both in the topics addressed and in the methods applied.

The new risk communication training:

- Views risk and crisis communication as related but distinct realities. Although risk communication is seen as the foundation on which successful crisis communication can refer and rely on, risk communication is seen as having a different broader social format, rationale and rules.
- Does not focus exclusively on outbreak scenarios and early communication to prepare for these outbreaks and other health crises. The course put an emphasis on addressing

continuous infectious disease risk communication challenges e.g. antimicrobial resistance and vaccination uptake;

- Understands risk communication as having more to do with knowledge- and relationship building than simple information conveyance. The training adopted a de-constructive approach and facilitated a look at the discourses that shape people's decisions and behaviour;
- Sees effective risk communication strategies as context dependent. The training aimed to help participants to *understand* the concepts that underlie risk communication advice before they are able to really implement "good advice" on risk communication strategies into their own realities. It is not enough to follow a set protocol with practical risk communication advice (e.g. be honest, communicate early, etc.). Once underlying risk communication concepts are understood and internalised, appropriate practical activities follow in an easy and intuitive way;
- Adopts a reflective approach. Rather than emphasising detailed guidance that lists the steps to go from A to B, the training took a reflective approach that aimed to provide participants with a map, the skill and literacy to read the map and the ability to design their own risk communication strategies that work in their realities; and,
- Emphasises an interactive, critical and reflective process in groups. Rather than listening to lectures, a hands-on approach was utilised that engaged with participants and facilitates active learning, understanding and networking.

Objectives and methodological approach

The pilot training at ECDC in Stockholm took place on 17-18 January 2013 and was addressed to public health and communication experts working at ECDC and the EU Commission. The overall objective of the course was to develop the competencies of public health programme managers and practitioners to analyse, understand and apply risk communication concepts, principles and approaches to the prevention and control of communicable disease threats on regional, national and/or local levels.

Course organisation

Each day of the two-day course was organised into reflection and action sessions. The days started with reflection sessions introducing terms, definitions, approaches and gave time to discuss these. The afternoons were dedicated to actions: exploring ways to put concepts into

practice, testing ideas, working on scenarios related to both on-going and crisis challenges, discussing and getting feedback from others within small working groups and in the plenum.

In order to maximize the utility of the discussions and ensure "real-life" learning, each participant was asked to complete a pre-course assignment that included the development of a case study based on their own contextually specific experience. These case studies informed group work and plenum discussions.

Evaluation

The training was evaluated with a pre- and post-course questionnaire as well as day assessments at the end of first and the second day. The questionnaire used close-ended questions with a Likert scale and open questions where a content analysis was applied.

Pre-course questionnaire

In the pre-course questionnaire, participants were asked for the knowledge and experience to establish a base line to assess the progress and improvement at the end of the pilot training. The majority considered themselves as having good knowledge and experience (table 1).

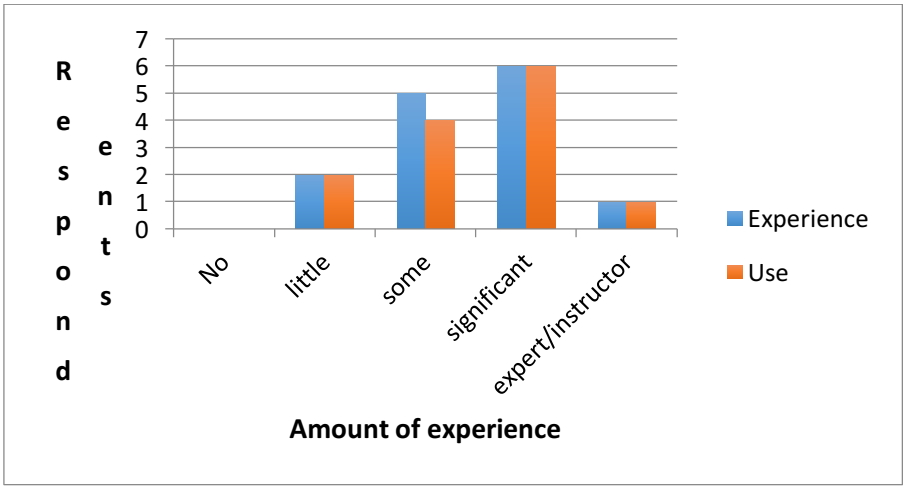

Table 1: Knowledge and experience of participants

The reason to participate in the training was mainly to receive a more formal training in risk communication as this was considered important for their field of work.

Expectations were practical and conceptual: participants wished for a structured approach, practical examples and tools; they also hoped for a better understanding of the different concepts and approaches.

Asked for a working understanding of risk communication, participants saw communication and risk communication as instruments to ensure trust and transparency; they stressed the importance of risk communication in the prevention of infectious diseases and as foundation for crisis communication. The nature of risk communication was seen in the communication of risks and to provide information adapted to various people; risk communication in this meaning was seen as ability to respond to public information needs. Ultimately risk communication should empower people as better-informed people are more likely to modify their behaviour.

Summary

The majority of participants considered themselves as having good knowledge and experience in risk communication; which is unsurprising as the audience of the course was a mix of public health and communication experts. They wished for a more formal training in an important field of their work. Accordingly, their expectations were pragmatic such as a structured approach, practical examples and tools as well as aiming to better understand the concepts and approach.

Post-course assessment

After the course, participants were asked whether their expectations have been met and whether their conceptual understanding improved. Participants reported that their expectations had been fully met and that their understanding of concepts and approaches had increased significantly (table 2).

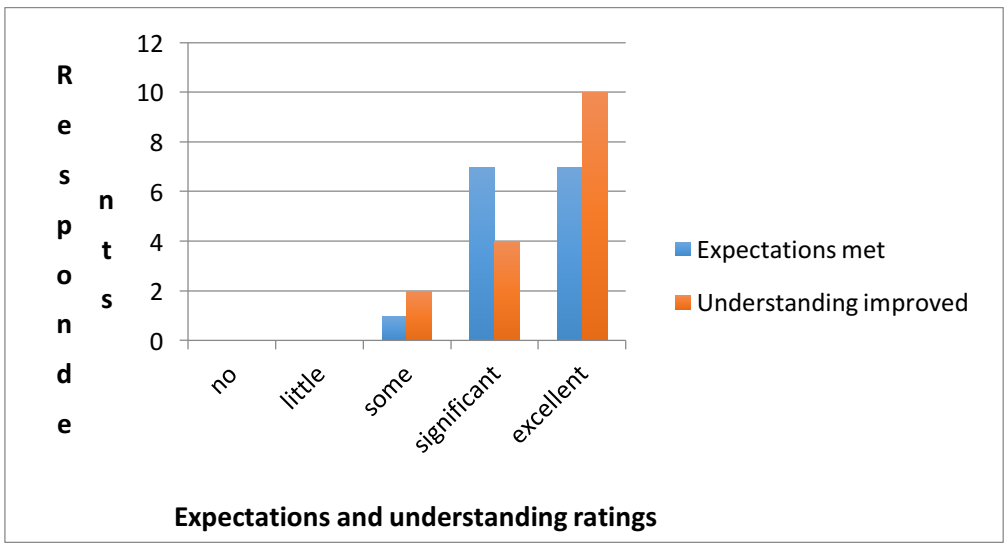

Table 2: Expectations met and understanding improved

Participants, who said earlier that they had good knowledge and understanding of risk communication, expressed the need for a paradigmatic change in the understanding and institutional practice of risk communication and felt better prepared to advocate for this change. The majority felt that the training was very useful and they provided constructive feedback to individual sections in the day assessments. Overall, they appreciated that the training was based on a reflective and reframing approach rather than on providing tips, checklists and concrete guidance.

Limitations

This article briefly introduces a new approach towards risk communication in public health and presents and reports on a pilot training in risk communication for public health experts designed according to this new approach.

The positive learning experience reported by the participants is encouraging; however, the composition of this group was exceptional as it consisted of European communication experts and public health experts and practitioners from all levels; this could have led to a positive bias in the evaluation, although others might contain that this was an overly critical group and such broad acceptance exceptional!

The training was a pilot with a small sample in a privileged setting. Its approach and training design needs to be tested in other settings with different target groups (e.g., community base practitioners and managers and organisational decision makers); and ultimately the changes it generates in public health policy and practice will need to be evaluated.

Conclusion

The training pilot was successful in conceptualising, articulating and introducing a new approach towards training the trainers in risk communication in public health. Further systematic analysis and evaluations of risk communication approaches and trainings are necessary to develop the capacity on the ground that is needed for the prevention of and response to public health incidents and emergencies. Future training in national and local settings will improve the curriculum and practice of risk communication and provide insights into the situation and landscape of risk communication on the ground and enhance our understanding of the practice of risk communication.

ECDC as developer and advocate of this training and approach is in the position to become an innovative and unique centre of expertise that could set the standard for the future of risk communication policy and practice in public health.

Funding

The training was founded by specific contract N. 12 - ECDC3442 Implementing Framework Contract N: ECDC/09/030.

Conflicts of Interest

The authors declare that they do not have a conflict of interest.

References

1. Apfel F. Health Communication. In: Cragg L, editor. Health Promotion Theory 2nd edition2013. p. 141-57.

2. Dickmann P, Rubin GJ, Gaber W, Wessely S, Wicker S, Serve H, et al. New influenza A/H1N1 ("swine flu"): information needs of airport passengers and staff. Influenza and other respiratory viruses. 2011;5(1):39-46.

3. Infanti J SJ, Barry MM, Nunez-Cordoba J, Oroviogoicoechea-Ortega C, Guillen-Grima F. A literature review on effective risk communication for the prevention and control of communicable diseases in Europe. Stockholm: ECDC, 2013.

4. Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007-2012. Vaccine. 2014;32(19):2150-9.

5. Fischhoff B. Risk perception and communication unplugged: twenty years of process. Risk analysis : an official publication of the Society for Risk Analysis. 1995;15(2):137-45.

6. Glik DC. Risk communication for public health emergencies. Annual review of public health. 2007;28:33-54.

7. Covello V, McCallum D, Pavlova M, disease Tfoecahal. Effective risk communication: the role and responsibility of government and nongovernment organizations New York, NY: Plenum; 1989.

8. Sandman P. Risk communication: facing public outrage. EPA J. 1987;13(21):21-2.

9. (WHO) WHO. WHO Outbreak communication guidelines. Geneva: 2005.

10. CDC. Crisis Emergency and Risk Communication 2012 (2nd Edition).

11. Abraham T. Lessons from the pandemic: the need for new tools for risk and outbreak communication. Emerging health threats journal. 2011;4:7160.
12. Burns WJ, Slovic P. Risk perception and behaviors: anticipating and responding to crises. Risk analysis : an official publication of the Society for Risk Analysis. 2012;32(4):579-82.
13. Slovic P. Perception of risk. Science. 1987;236(4799):280-5.
14. Atman CJ, Bostrom A, Fischhoff B, Morgan MG. Designing risk communications: completing and correcting mental models of hazardous processes, Part I. Risk analysis : an official publication of the Society for Risk Analysis. 1994;14(5):779-88.
15. Bostrom A, Atman CJ, Fischhoff B, Morgan MG. Evaluating risk communications: completing and correcting mental models of hazardous processes, Part II. Risk analysis : an official publication of the Society for Risk Analysis. 1994;14(5):789-98.
16. Kasperson J, Kasperson R, Pidgeon N, Slovic P. The social amplification of risk: assessing fifteen years of research and theory. In: Pidgeon N, Kasperson R, Slovic P, editors. The Social Amplification of Risk. Cambridge: Cambridge University Press; 2003. p. 13-46.
17. Sixsmith J, Doyle P, D'Eath M, Barry MM. Health communication and its role in the prevention and control of communicable diseases in Europe – Current evidence, practice and future developments. Stockholm: ECDC; 2014.
18. P. Doyle, J. Sixsmith, M.M. Barry, S. Mahmood, L. MacDonald, M.O'Sullivan, C.Oroviogoichoechea, G. Cairns, F. Guillen-Grima and J. Núñez-Córdoba. Public health stakeholders' perceived status of health communication activities for the prevention and control of communicable diseases across the EU and EEA/EFTA countries. Stockholm: ECDC, 2012.
19. Abraham T. Risk and outbreak communication: lessons from alternative paradigms. Bulletin of the World Health Organization. 2009;87(8):604-7.
20. Larson HJ. Negotiating vaccine acceptance in an era of reluctance. Human vaccines & immunotherapeutics. 2013;9(8):1779-81.
21. ECDC. Literature review on trust and reputation management in communicable disease in public health. Stockholm: ECDC, 2011.
22. Weaver WS, Claude Elwood. The Mathematical Theory of Communication University of Illinois Press; 1963.
23. Neiger BL, Thackeray R, Burton SH, Giraud-Carrier CG, Fagen MC. Evaluating Social Media's Capacity to Develop Engaged Audiences in Health Promotion Settings: Use of Twitter Metrics as a Case Study. Health promotion practice. 2013;14(2):157-62.
24. UNICEF. Behaviour change communication in emergencies: A toolkit. 2006.

25. MacDonald L, Cairns G, Angus K, Stead M. Evidence review: social marketing for the prevention and control of communicable disease. Stockholm: ECDC; 2012.
26. French J, Blair-Stevens C, Merrit R, McVey D. Social marketing and public health, theory and practice. Oxford: Oxford University Press; 2009.
27. ECDC. Social marketing guide for public health managers and practitioners. Stockholm ECDC, 2014.
28. WHO. The Ottawa Charter for Health Promotion. Ottawa, Canada 1986.
29. Kickbusch I, Behrendt D. Implementing a Health 2020 Vision: Governance for Health in the 21st Century- Making it Happen WHO Regional Office for Europe. Copenhagen 2013.
30. Kickbusch I, Gleicher D. Governance for health in the 21st century. WHO Regional Office for Europe, Copenhagen, 2013.

2. RE-THINKING RISK COMMUNICATION: information needs of patients, health professionals and the public regarding MRSA - The communicative behaviour of a public health network in Germany responding to the demand for information[19]

Abstract

Objectives: Multidrug resistant organisms (MDRO), including Meticillin-resistant *Staphylococcus aureus* (MRSA), and healthcare associated infections (HCAIs) are pressing issues for healthcare systems across the world.

Information and communication are considered key tools for the prevention and management of infectious diseases. Public Health Authorities (PHA) are in a unique position to communicate with health care professionals, patients and the public regarding the health risks.

Study design: We used PHA helpdesk interaction data to first ascertain the information requirements of those getting in contact with the service, and secondly to examine the communicative behaviour of the PHA, with a view to improving the quality of communication strategies.

Method: Data on helpdesk interactions between 2010 and 2012 was obtained from a MDRO network of nine German PHAs. 501 recordings were coded and descriptive statistics generated for further qualitative thematic analysis.

Results: Our analysis revealed a similar pattern of questions among different groups. Key areas of need for information were around eradication, cleaning and isolation measures. Reported problems were a lack of expert knowledge and continuity of treatment. The helpdesk response was mainly a conversation offering scientific advice, but also included other communication services that went beyond the provision of scientific facts, such as follow up calls, referral suggestions and consultations on behalf of the caller. These social communication activities seem to have an important impact on the acceptability of public health recommendations and use of the helpdesk.

Conclusions: Our findings support a broader discussion about the role of information in the communication process and underline the importance of social elements in the communication process, such as relationship and trust building.

---

19 Petra Dickmann, Katharina Wittgens, Sam Keeping, Dorothea Mischler and Ursel Heudorf (2015): Re-thinking risk communication: information needs of patients, health professionals and the public regarding MRSA - the communicative behaviour of a public health network in Germany responding to the demand for information. Public Health 12/2015.

Keywords: MRSA, Information needs, Risk Communication, Antimicrobial Resistance, Public Health

Acknowledgement: This research was funded by European Commission 7th Framework Programme (FP7 – 2007-2013) under Grant Agreement 242058, EUCBB (European Union Cross Border Care Collaboration).

Introduction

Antimicrobial resistance and healthcare associated infections (HCAIs) are major topics on health policy agendas in countries across the world.[1-4] The Chief Medical Officer in the UK, Professor Dame Sally Davies, recently described the threat posed by antimicrobial resistance as "catastrophic" and put it on the same level of seriousness as international terrorism.[5] The rise in meticillin-resistant *Staphylococcus aureus* (MRSA) infections represents a nexus between two important problems: healthcare associated infections and antibiotic resistant bacterium. With patients increasingly travelling to other countries for treatment and the growth of cross border health care, the prevalence of MRSA and other multidrug resistant organisms (MDRO) has developed a pan-European dimension which must be combated in order to ensure consistent quality of care and safeguard patients.[6-8]

Previous research has investigated the information needs of patients and health care professionals with regards to different diseases and when choosing between health care providers.[9-12] Public health authorities (PHA) are deemed to be in a unique position to communicate with healthcare professionals, patients, the public and other stakeholders about health risks and in turn can offer advice regarding to infection control. They are also in the position to advise both patients and health professionals regarding treatment and provide evidence-based recommendations to aid the smoothness of patients' journeys through the different parts of the healthcare system (home, primary care, secondary care, long term care).

The potential for movement within as well as across these different sectors, within and across different countries, has been highlighted as a major risk factor for increasing the spread of infections such as MRSA. [13-15] This led some to call for the urgent creation of professional networks to support the coordination and structure of care for patients with MRSA within countries, in cross-border regions and internationally. In response, the German federal ministry of health decided in 2006 to develop regional MDRO networks across the country.[16-17] In the Rhine-Main region, a MDRO network of nine PHAs was founded in 2010, covering around 250 participating organisations (e.g. medical institutions, long term care facilities, various organisations for patient transport). One of the services provided by the network is a helpdesk

offering advice to healthcare professionals, patients and the wider public. One qualified study nurse is in charge of the helpdesk answering calls during opening hours. During out-of-hours an answering machine records the entries and calls are returned the next day. Only in times of absence (e.g. vacation), a second study nurse replaces the person in charge. Both nurses have access to a network of physicians, microbiologists and experts in antibiotic therapy.
At the time of the study, only around two or three other networks offered personal information services to patients or relatives. The helpdesk has a unique position as information service for both professionals and lay-people alike and is embedded in network activities with frequent meetings and contacts with network members.
The helpdesk provides a high competent person at first contact to answer the questions or provide another service. This helpdesk was created as members of the public health authority perceived a lack of information and evidence-based recommendations for specific situations. The helpdesk is paid for by a grant from the ministry of health for a period of five years (2010-2015).

Information and communication are considered vital activities in the prevention and management of infectious diseases.[11] Previous research stress the importance of engaging with patients and providing information.[18-19] However, commentators on health communication, and risk communication in particular, are beginning to focus less on the role of scientific fact provision and instead emphasise the importance of social elements of communication such as relationship and trust building.[20-22] The evidence base for the recommendation of risk communication strategies is still limited.[22] Empirical studies analysing the communicative behaviour of public health authorities are much needed if measures to prevent and manage infectious diseases are to be improved.

Research focus and questions

This article looks at who are the main users of PHA/MDRO network information helpdesks, what information they most commonly request regarding MRSA, the means by which they were made aware of the service and the communicative behaviour of PHA responding to their requests. We also investigated the media's influence on service use. By investigating information needs and communicative behaviour, we hoped to identify ways by which communication of health care related information might be improved in the future.

Methods

The helpdesk provided a database of 577 recordings of calls featuring questions about MRSA from between May 2010 and May 2012. The raw data included information on the type of caller (patient, healthcare professional etc.), their location, the affected party, to whom the request related, the means by which they came aware of the helpdesk and the content of their request. The recordings were assessed for eligibility by applying predetermined criteria. After this initial screen, 501 recordings were deemed to be eligible for further analysis.

A preliminary coding manual was developed and piloted on a sample of 200 calls. The manual was then amended and finalised based on the information garnered from the pilot after which it was applied to the entire sample in order to provide answers to the main research questions. Once the data had been coded, descriptive statistics were generated for the different classes of questions and also their trigger, grouped by caller type. Relative frequencies for the different responses offered by the helpdesk were also constructed. The trend in media spurred calls was also plotted against major events in order to visually assess any potential correlation. Descriptive statistic data were then used for qualitative thematic analysis.

Results

1) Distribution of calls

While the distribution of different callers remains roughly the same, the monthly calls increase from 18 in 2010 to 22 in 2011 and 33 in 2012.

Year	Months	Number of calls	Number of questions	Monthly call average	% of questions by doctors	% of questions by nurses	% of questions by private people
2010	May-Dec (8 months)	143	137	17.9	31.4	11	57.7
2011	Jan-Dec (12 months)	264	243	22	20.2	21	58.9

2012	Jan-May (5 months)	167	121	33.4	31.4	20.7	47.9

Table 1: Distribution of calls

2) Caller groups

Three different caller types were identified: doctors, nurses (in care homes), and private individuals (patients and their relatives). In 2010, 58% of questions to the helpdesk came from private individuals, 31% were asked by doctors and 11% by nurses. In 2011, the share of calls coming from doctors fell to around 20% at the same time as calls from nurses rose to 21%. The percentage of questions asked by private individuals remained roughly the same at 59%. In contrast, the proportion of total calls from private individuals fell in 2012 (48%), with doctors' share increasing (31%) and nurses staying at close to the same level as the year before.

3) Key areas of interest

Ten main questions, each with between two to six sub-categories, were identified from the database. Most of the questions asked by doctors and nurses were about eradication. The second most common question by doctors and nurses was regarding hygiene measures. Nurses were also shown to be commonly asking questions about the isolation of MRSA patients. Private individuals were mostly concerned about the control and eradication of MRSA; they also reported a lack of sufficient information as well as a refusal to be treated.

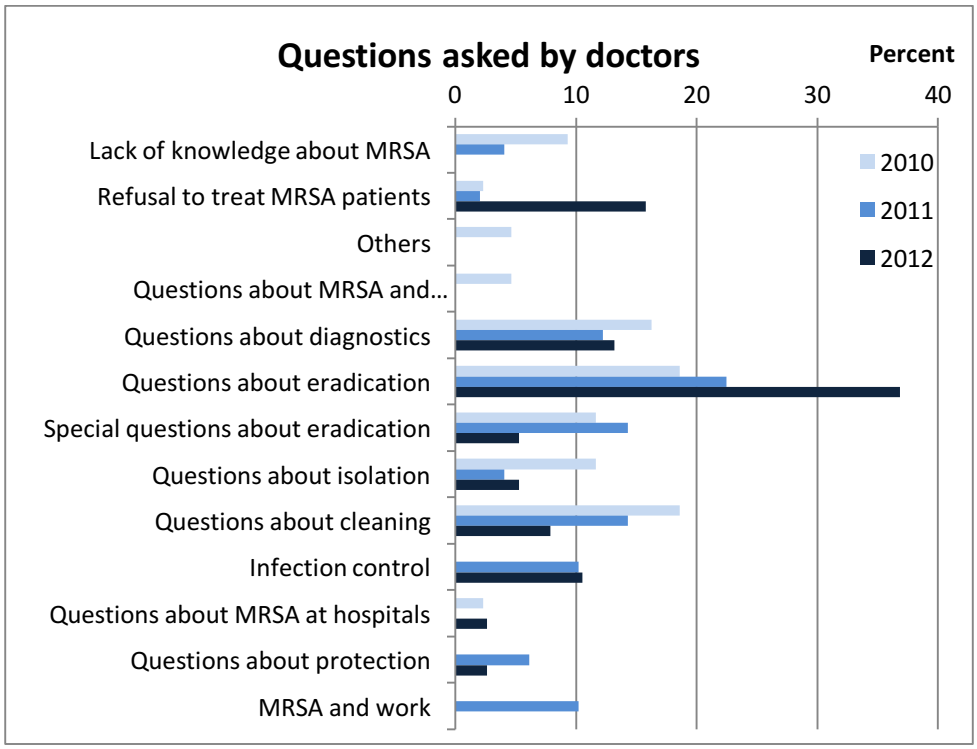

Table 2a: Questions from doctors

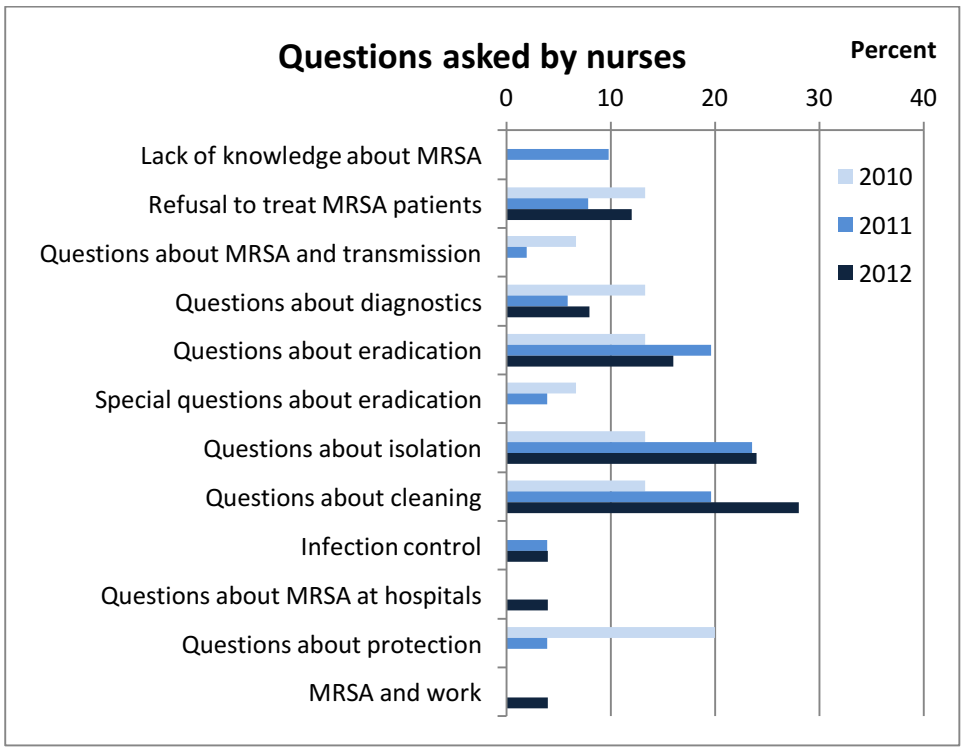

Table 2b: Questions from nurses

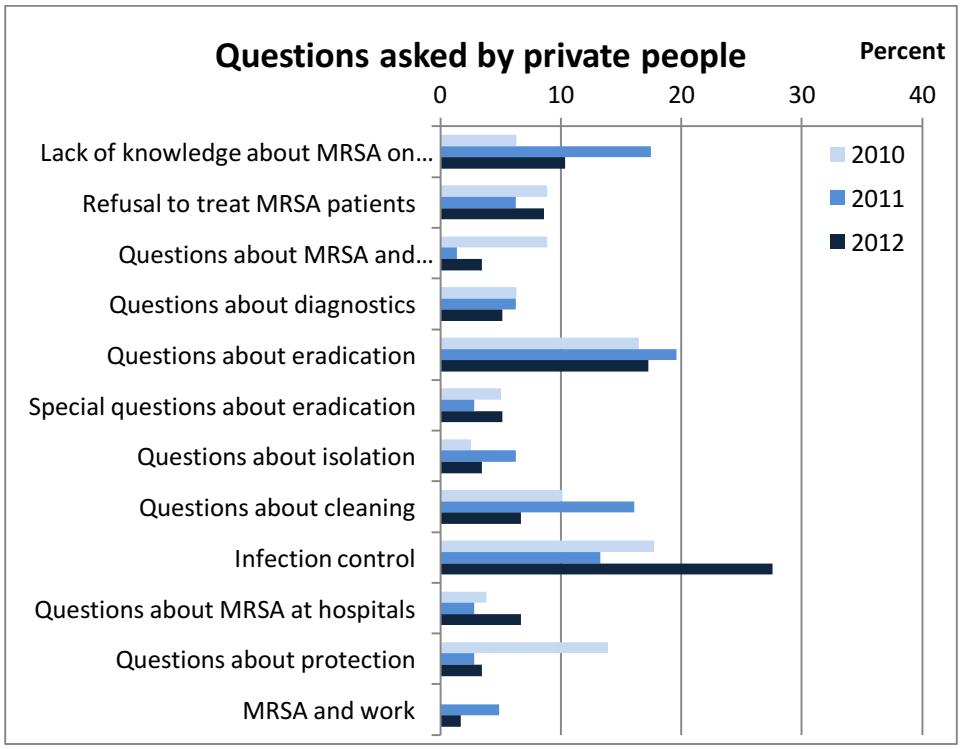

Table 2c: Questions from private people

4) Contact reasons

The most frequently occurring reasons for contacting the helpdesk were concerns regarding current treatment, problems in the referral process of a patient, costs involved and a mix of case specific questions about treatments for MRSA. Another frequent reason was to ask for expert advice for a particular situation. A smaller proportion of callers contacted the helpdesk exclusively for confirmation of medical advice and/or reassurance with regards to social circumstances or emotional aspects of infection with MRSA. These covered subjects such as stigma, bullying, hysteria, general anxiety regarding contracting the bacterium and scepticism regarding professional advice.

5) Helpdesk activities

The majority of helpdesk activities were isolated one-to-one verbal conversations held over the phone (activity completed 2010: 60%/2011: 57%/2012: 67%). However, the helpdesk also double-checked and confirmed information with colleagues (8%/9%/2%); followed-up or offered a follow-up call (10%/9%/3%); contacted a health care professional on behalf of the patient or caller to discuss the particular service (6%/4%/6%); provided more/additional information (such as flyer, internet addresses, etc.) (11%/13%/15%); and referred callers to named/known colleagues or institutions (5%/8%/7%).

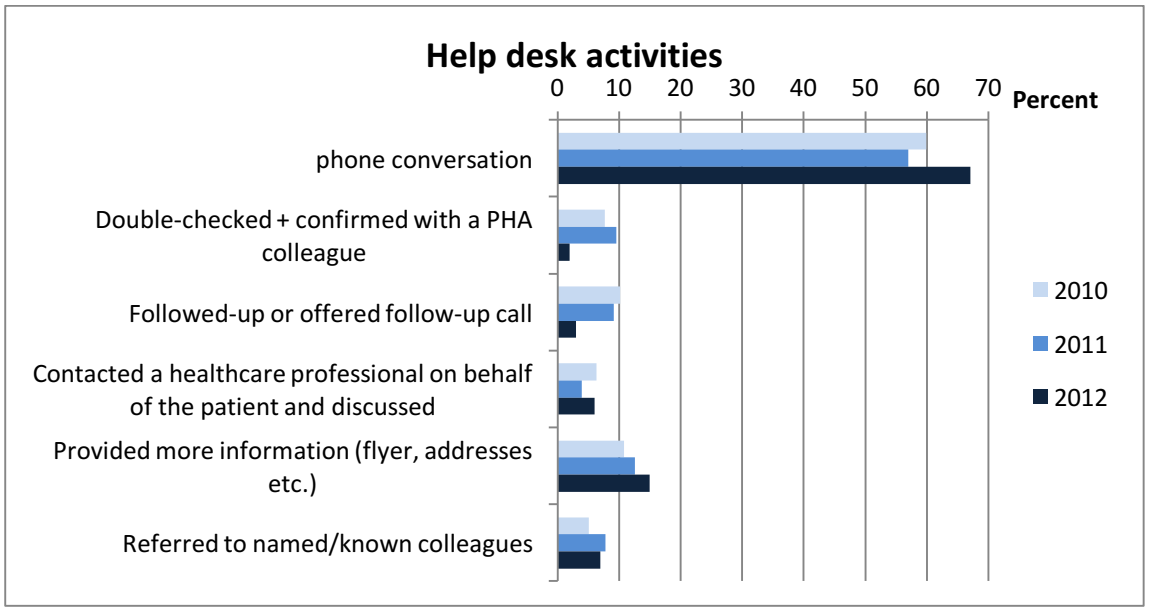

Table 3: Helpdesk activities

6) Feedback

The feedback from the callers was difficult to obtain as it was not explicitly asked for and noted in the raw database categories. However, where feedback was noted, callers expressed their gratefulness and acknowledged the value of the helpdesk service, which is to some degree reflected by the increasing number of repeat callers year by year.

7) Role of the media

Callers mentioned different triggers for contacting the PHA helpdesk such as the use of the internet, interactions in hospital and GP visits.

An increase in calls, especially among private people, could be seen after one major local newspaper "*Frankfurter Rundschau*" had published an article on MRSA called "*Killerkeime*" ("killer bugs"). Other peaks were recognised in October 2011 and March 2012 following the advertisement of the helpdesk services in local newspapers and health care facilities.

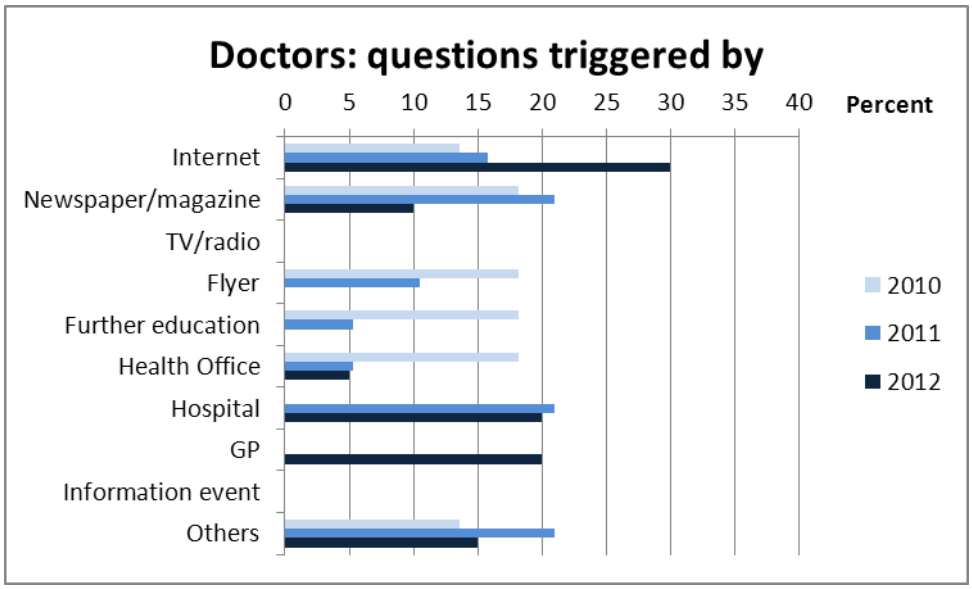

Table 4a: Triggers of doctors

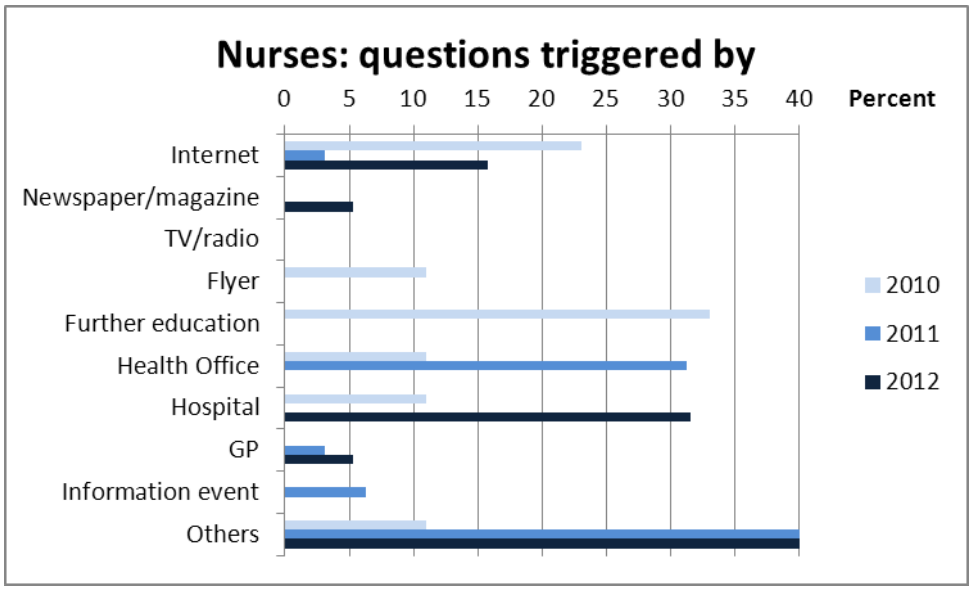

Table 4b: Triggers of nurses

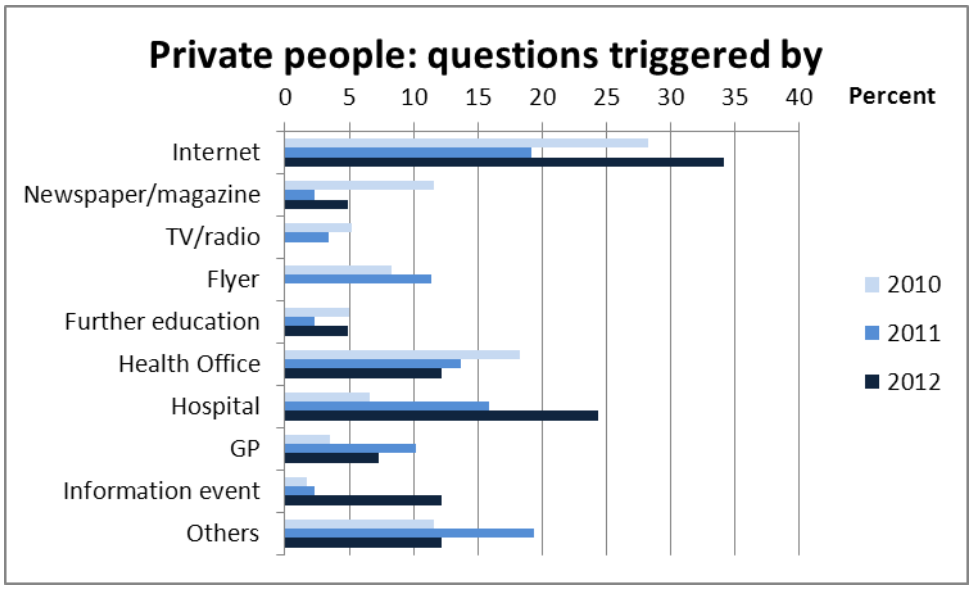

Table 4c: Triggers of the public

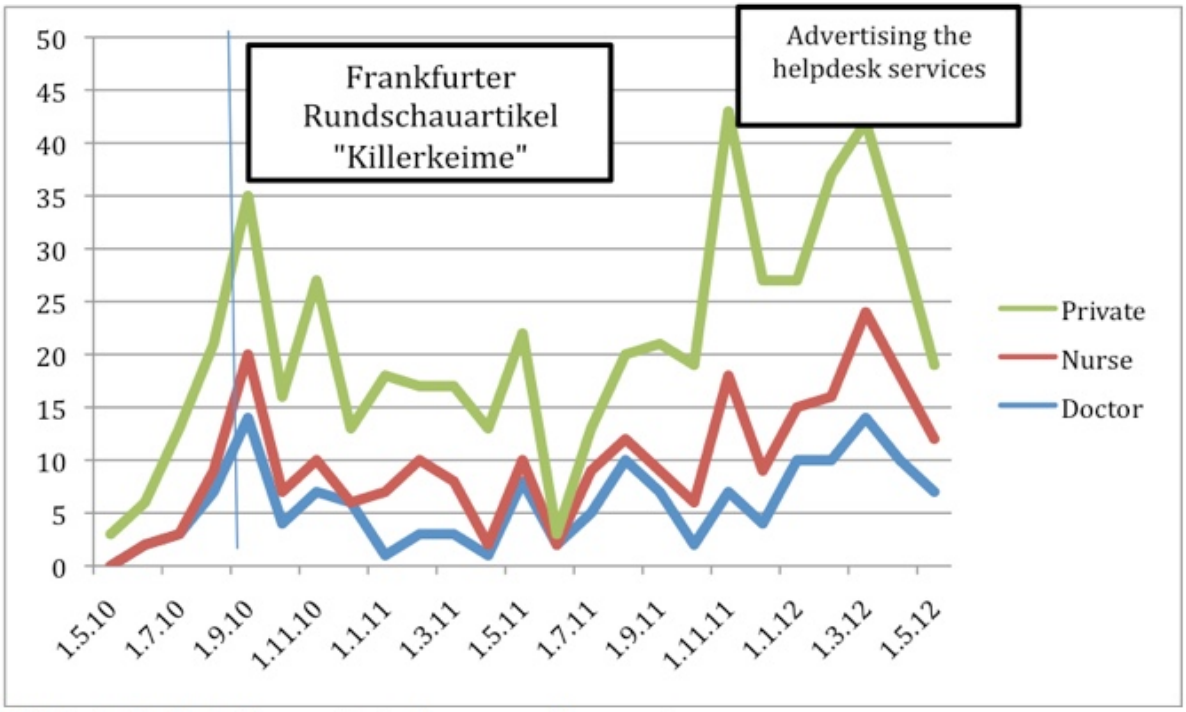

Table 5: Calls in the context of mass media events

Discussion

Thematic distribution of questions

The results of our analysis show that health care professionals (both doctors and nurses) as well as patients and relatives contact the MDRO network helpdesk, with a high level of consistency

in terms of the questions. While the distribution of different callers remains roughly the same, the monthly calls increase. We understand this increase of calls as a sign for acceptance, increasing popularity and proof of usefulness of the helpdesk.

Nursing staff

Nursing home staff were mainly concerned with issues relating to cleaning and hygiene, isolation practices and eradication measures, as these represent their main responsibilities. The consistent nature of the types of questions among this population suggests that informational needs are not being addressed elsewhere, as this information should be seminal to their daily activities.

Nursing staff also contacted the helpdesk because of perceived problems in the continuity of care for MRSA patients ("refusal to treat MRSA patients"). This seems to indicate organisational issues as opposed to knowledge deficiencies of callers, and also demonstrates a belief of nurses that the helpdesk might be able to influence those in charge of organising care as well as provide recommendations.

Doctors

Doctors were found to mainly ask questions about eradication and cleaning. Other information needs identified related to diagnostics and specific aspects of eradication. Again, these themes are stable over the observed time period and reflect the responsibility and tasks of doctors. A peak in 2012 indicates problems in the continuity of treatment of MRSA patients that corresponds with the results from the nursing staff.

Public

Private individuals contacted the helpdesk mainly regarding questions about eradication and infection control. Their information needs were also focussed on cleaning (with a peak seen in 2011) and questions about protection against infection (peaking a year earlier). Interestingly, the public contacted the helpdesk due to lack of sufficient information provided by healthcare professionals. The calls from members of the public also indicated a persistent problem in the form of continuity of care due to refusals to continue treatment.

The thematic distribution of questions reveals two major aspects: all groups report a persistent problem with the continuity of care and they indicate a lack of sufficient information. It is, however, interesting to note that while information is widely available and can be obtained

from several sources, such as GPs, online, books, magazines, people decide to call the helpdesk.

The role of the Public Health Authority

The helpdesk was set up expressly to provide scientific advice and support services in order to improve the management of MRSA patients. The majority of activities were interactive telephone conversions where advice was given.

People called the helpdesk for clarification on medical issues, but also they also called the helpdesk looking for emotional support, with the expressed intent of gaining confirmation, reassurance and clarification in frightening, disturbing or upsetting situations. The helpdesk took care of the patients or caller: follow up calls, referral suggestions, consultations with other professionals on behalf of the caller were all found to be important parts of the helpdesk's activities. The importance of these more social elements of calls was reflected in increasing appreciation resulting in repeat calls and explicit expression of gratitude.

Media triggers

The mass media is an important information channel and raises awareness in most parts of the population. In our analysis, its impact was seen most among private people. This is an interesting finding that requires further investigations regarding the hypothesis that population groups with relatively little knowledge react more easily and people with more expert knowledge are more resilient to media coverage. This investigation could help design risk communication activities that aim at preventing 'media hypes'.

The analysis of the helpdesk data does show that there appear to be transient increases in call frequency following media coverage. However, both the pattern of information needs and call triggers remain the same over the observed period of time, suggesting there is persistent interest and consequent information needs among professional groups and members of the public.

Limitations

This analysis has a number of limitations. It is a quantitative re-analysis of an existing database where the categories were developed independently from the research questions. Therefore, only a limited spectrum of quantitative data could be used for the analysis.

The original data lacked some information that would have been important to look at: neither the duration of the calls, nor the names of the callers, or the person who answered the call were recorded. Therefore, we could not elaborate any insights into different outcomes, such as longer

calls, more repeats, more referrals, etc. As a result of our investigation we suggest the inclusion of further categories such as activities of the helpdesk, feedback of the callers, duration of call, etc. to the dataset.

The qualitative approach was a convenient selective content analysis that helped to clarify questions that came up during the quantitative analysis ("Why did people call the helpdesk?"). Qualitative research could reveal more insight into the softer parts of the communication interactions and should be investigated further.

Conclusion

Social role of information: information hotline vs. helpdesk

Despite the fact that the majority of information requested is widely available on the internet, in leaflets (for patients and relatives), textbooks and further training material for health care professionals, both health care professionals and private individuals regularly contacted the helpdesk. There are two possible explanations: first, the main reason for calling is not information, but the social role and function the helpdesk provides represented in an interactive conversation and possible further communication services (follow ups, consultants, referrals, etc.). Second, the information that is widely available is not sufficient; background or context-related information and knowledge or experience is also needed in order to understand the situation and information given. Both explanations seem to be relevant for our research questions and point to a need for further research.

Knowledge and communication gaps seem to be a problem that is most apparent for private individuals. Distressing experiences with healthcare professionals appear to leave them with no, incorrect or confusing information regarding further management and hence insufficient explanations being cited as a common reason to contact the helpdesk. Further research needs to be undertaken to investigate whether there are systemic failures in education and training for professionals, and how to improve ways to respond to these knowledge communication gaps.

The activities provided by the helpdesk point to the conceptual understanding of the role of information and communication in the management of infectious patients. Information and communication is not only about the scientific facts; it is an important social activity in terms of relationship building. Offering a human interaction, putting patients in contact with a recommended and known expert/colleague; following up, contacting and discussing matters on behalf of the caller, all these activities are major elements of effective risk communication.

Further research needs to be done to establish a framework to better understand the role and function of risk communication in public health.

Conflict of Interest

The authors declare that they do not have a conflict of interest. PD did this research during her fellowship at the London School of Economics (LSE) and has since 2013 set up her own consultancy on strategic risk communication. There are no financial or other benefits that could pose a conflict of interest.

Ethics approval

As we re-analysed a pre-existing database, ethics approval was not considered necessary.

References

1. Bajardi P, Poletto C, Ramasco JJ, Tizzoni M, Colizza V, Vespignani A. Human mobility networks, travel restrictions, and the global spread of 2009 H1N1 pandemic. *PloS One* 2011;6:e16591.

2. Dulon M, Haamann F, Peters C, Schablon A, Nienhaus A. MRSA prevalence in European healthcare settings: a review. *BMC Infect Dis* 2011;11:138.

3. Borg MA, Camilleri L, Waisfisz B. Understanding the epidemiology of MRSA in Europe: do we need to think outside the box? *J Hosp Infect* 2012;81:251-6.

4. Tiemersma EW, Bronzwaer SL, Lyytikainen O, et al. Methicillin-resistant Staphylococcus aureus in Europe, 1999-2002. *Emerg Infect Dis* 2004;10:1627-34.

5. Davies SC. Annual Report of the Chief Medical Officer, Volume Two, 2011, Infections and the rise of antimicrobial resistance. London: Department of Health; 2013.

6. Grundmann H, Aanensen DM, van den Wijngaard CC, Spratt BG, Harmsen D, Friedrich AW. Geographic distribution of Staphylococcus aureus causing invasive infections in Europe: a molecular-epidemiological analysis. *PLoS Med* 2010;7:e1000215.

7. Kock R, Becker K, Cookson B, et al. Methicillin-resistant Staphylococcus aureus (MRSA): burden of disease and control challenges in Europe. *Euro Surveill* 2010;15:19688.

8. Kock R, Brakensiek L, Mellmann A, Brakensiek, L, Mellmann A, Kipp F, Harmsen D, Daniels-Haardt I, von Eiff C, Becker K, Hendrix M, Friedrich AW. Cross-border comparison of the admission prevalence and clonal structure of meticillin-resistant Staphylococcus aureus. *J Hosp Infect* 2009;71:320-6.

9. Verhoeven F, Steehouder MF, Hendrix RM, van Gemert-Pijnen JE. How nurses seek and evaluate clinical guidelines on the Internet. J Adv Nurs 2010;66:114-127.
10. Verhoeven F, Steehouder MF, Hendrix RM, van Gemert-Pijnen JE. Factors affecting health care workers' adoption of a website with infection control guidelines. *Int J Med Inform* 2009;78:663-78.
11. Dickmann P, Rubin GJ, Gaber W, Serve H, Gottschalk R. New influenza A/H1N1 ("swine flu"): information needs of airport passengers and staff. *Influenza Other Respi Viruses* 2011;5:39-46.
12. Rubin GJ, Amlot R, Carter H, Large S, Wessely S, Page L. Reassuring and managing patients with concerns about swine flu: qualitative interviews with callers to NHS Direct. *BMC Public Health* 2010;10:451.
13. Daniels-Haardt I, Verhoeven F, Mellmann A, Hendrix MG, Gemert-Pijnen JE, Friedrich AW. EUREGIO-projekt MRSA-net Twente/Munsterland. Creation of a regional network to combat MRSA. *Gesundheitswesen* 2006;68:674-8.
14. Friedrich AW, Witte W, de Lencastre H, Hryniewicz W, Scheres J, Westh H. A European laboratory network for sequence-based typing of methicillin-resistant Staphylococcus aureus (MRSA) as a communication platform between human and veterinary medicine - an update on SeqNet.org. *Euro Surveill* 2008;13:18862.
15. Coia JE, Duckworth GJ, Edwards DI, et al. Guidelines for the control and prevention of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities. *J Hosp Infect* 2006;63:S1-44.
16. Robert Koch Institute. Der Umgang mit MRSA Patienten in deutschen Krankenhäusern. Epi Bull 2011;15:119-21.
17. Robert Koch Institute. Kommentar zu den "Empfehlungen zur Prävention und Kontrolle von MRSA-Stämmen in Krankenhäusern und anderen medizinischen Einrichtungen". Hinweise zur Risikopopulation für die Kolonisation mit MRSA. *Epi Bull* 2008;42:363-4.
18. Gudnadottir U, Fritz J, Zerbel S, Bernardo A, Sethi AK, Safdar N. Reducing health care-associated infections: patients want to be engaged and learn about infection prevention. Am J Infect Control. 2013;41(11):955-8.
19. Ottum A, Sethi AK, Jacobs E, Zerbel S, Gaines ME, Safdar N. Engaging patients in the prevention of health care-associated infections: a survey of patients' awareness, knowledge, and perceptions regarding the risks and consequences of infection with methicillin-resistant Staphylococcus aureus and Clostridium difficile. Am J Infect Control. 2013;41(4):322-6.

20. Apfel F. Health Communication. In: Cragg L, editor. Health Promotion Theory 2nd edition 2013:141-57.
21. Dickmann P. Introducing a new risk communication paradigm. *Eur J Public Health* 2013;23(suppl 1).
22. Infanti J SJ, Barry MM, Nunez-Cordoba J, Oroviogoicoechea-Ortega C, Guillen-Grima F. A literature review on effective risk communication for the prevention and control of communicable diseases in Europe. Stockholm: ECDC 2013.

3. RISK COMMUNICATION OF ANTIMICROBIAL RESISTANCE: The Role of Clinical Practice, Regulation and Other Policies in Five European Countries in regards to MRSA[20]

Abstract

Background: The threat posed by Meticillin-resistant *Staphylococcus aureus* (MRSA) has taken on an increasingly pan European dimension. This article aims to provide an overview of the different approaches to the control of MRSA adopted in five European countries (Austria, Germany, Netherlands, Spain and the UK) and discusses data and reporting mechanisms, regulations, guidelines and health policy approaches with a focus on risk communication.

Our hypothesis is that current infection control practices in different European countries are implicit messages that contribute to the health-related risk communication and subsequently to the public perception of risk posed by MRSA.

A reporting template was used to systematically collect information from each country.

Discussion: Large variation in approaches was observed between countries. However, there were a number of consistent themes relevant to the communication of key information regarding MRSA including misleading messages, inconsistencies in content and application of published guidelines, and frictions between the official communication and their adoption on provider level.

Summary: The variability of recommendations within, and across, countries could be contributing to the perception of inconsistency. Having inconsistent guidelines and practices in place may also be affecting the level at which recommended behaviours are adopted. The discrepancy between the official, explicit health messages around MRSA and the implicit messages stemming from the performance of infection control measures should therefore be a key target for those wishing to improve risk communication.

Keywords: MRSA, healthcare associated infections (HCAI), Risk communication, Infection control, Health policy

[20] Petra Dickmann, Sam Keeping, Nora Döring, Andrea E Schmidt, Claudia Binder, Sergio Ariño-Blasco and Joan Gil(2017): Communicating the Risk of MRSA: The Role of Clinical Practice, Regulation and Other Policies in Five European Countries. Front. Public Health 5:44. doi: 10.3389/fpubh.2017.00044

Background

Healthcare associated infections (HCAIs) place a significant burden on health systems in terms of both morbidity and mortality, and their effects are felt far beyond just those utilising healthcare services [1]. An already serious situation is now being exacerbated by the growth of antibiotic-resistant bacteria, such as meticillin-resistant *Staphylococcus aureus* (MRSA). MRSA is a bacterium which is resistant to ß-lactam antibiotics, a group of antibiotic treatments which includes penicillin and cephalosporin. Infection with MRSA can lead to a variety of sequelae, including ventilator-associated pneumonia, chronic wound infection, bloodstream infection (bacteraemia) and septic conditions, which in some circumstances can lead to death.

The prevalence of MRSA varies across Europe, with a general trend of increasing prevalence from north to the south [2-4]. The reasons for these observed differences are not yet fully understood, although variation in prevention and control strategies [5], design of healthcare facilities [6], staff to patient ratios [7], patterns of antibiotic usage [8] and the implementation of antibiotic stewardship [9, 10] are thought to be contributing factors. As travel between European states becomes more common, with citizens free, within certain limits, to pursue elective treatment in a European country other than their own, the scope for transmission of infectious pathogens to areas where they are not endemic becomes ever greater [11, 12]. Therefore, cross border regions now face a particular challenge in coping with patients coming from neighbouring countries where different regulations and practices are in place to prevent, detect and respond to infectious agents [13]. The rise of MRSA and the European cross border health care legislation to allow treatment in another EU country have led to the formation of a number of MRSA networks, founded on bilateral agreements between countries with shared borders about how best to manage the issues outlined above [14].

Increases in the burden associated with HCAIs and the growth of antimicrobial resistance have led to heightened awareness both within the lay population and among politicians [15]. The Chief Medical Officer in the UK has even gone so far as to place the threat posed by antimicrobial resistant on a par with that of terrorism [16]. The European Centre for Disease Prevention and Control (ECDC) has placed the “Antimicrobial Resistance and Healthcare-associated Infections Programme” among its top priorities for the future [17]. The ECDC has also stated that a major part of the problem stems from deficiencies in the way health related issues are communicated, and has encouraged EU member states to improve their risk communication strategies [18].

Risk communication is a wide and multi-faceted field, and is considered an important approach in the fight against the spread of infectious diseases through the impact it can have on the adoption of appropriate behaviours e.g. frequent hand washing to limit carriage and infection [19]. Recent research has highlighted a number of areas which are key to understanding effective risk communication, such as the nature and quality of information provided to patients and health care workers [20], patients' and the general public's perceived information needs [21, 22] and role of the media [23]. However, little research has been carried out into the impact of institutional arrangements on specific communication strategies [24].

We conceptualise risk communication as not simply explicit communications, but also the implicit messages of institutional arrangements (differences in policies, inconsistencies of implementation, etc.). In order to test this assumption, we examined the implementation of various MRSA policies across five European countries for any evidence that environmental factors contribute as implicit and 'autonomous' risk communication next to traditional explicit and 'voluntary' forms.

The article begins by discussing the situation in each of the countries with regards to the following areas, while reflecting on the underlying epidemiological rationale for each:

- Data and reporting mechanisms,
- Regulations and guidelines,
- Health policy approaches with a focus on risk communication, and
- Implicit messages of current practices.

In the second section, we move on to discuss how different national strategies to contain MRSA infection are implicit 'messages' and contribute to explicit risk communication strategies.

Methods

We collected information on the situation with regards to MRSA in five European countries until 2011: Austria, Germany, Netherlands, Spain and the UK. These countries were chosen as they represent varying prevalence, response strategies, overall health system organization and modes of communication.

A template was designed to systematically collect information about five areas: 1) data collection and reporting mechanisms; 2) the regulatory framework; 3) clinical guideline design; 4) implementation of guidelines and 5) other relevant health policy measures. The intended and unintended effects of policies in each of these categories were then compared to explicit

communication strategies first by country, and then across countries. Information was drawn from scientific and grey literature and complemented, where necessary, by stakeholder interviews.

To help interpret the results, and how the various measures compare to one another, we developed a stepwise classification for different stages of MRSA (see Table 1).

Level I	**Colonisation**	MRSA can be found on the skin, in the nasal cavity or in a wound. The colonisation itself is not an ostensible health problem; however, it can lead to an acute infection and most importantly MRSA is contagious from the level of colonisation on. Healthy people are still healthy with MRSA colonisation, but could spread the bacterium to others. For ill people MRSA colonisation could lead to an infection with the bacterium. With an easy and non-invasive swab the colonisation can be identified. A proven colonisation can be sanitised with antibiotic cream and antiseptic washings.
Level II	**Infection**	MRSA is on the skin or in the nasal cavities or in wounds and causing a reaction from the immune system e.g. inflammation, antibodies, fever, etc. The infection can be proven by a blood test showing the systemic signs of an immune system reaction and the bacterium be found locally in the infection area. Patients with a compromised immune system or with skin problem are more susceptible to developing MRSA infections than healthy people.
Level III	**Bacteraemia**	Bacteria can be found in the bloodstream. In combination with clinical symptoms this is called sepsis. A septic condition is a serious, life threatening medical condition. Bacteraemia is proven by a blood sample where bacteria can be found. A blood test for bacteraemia is only performed when medically indicated e.g. a patients developing a septic clinical condition.

Table 1 Classification of MRSA from an infection control perspective

Results

We present narratively a summary of results; the details can be found in table 2.

Data situation

Of the five countries, three countries have mandatory reporting (Germany, Netherlands and UK) while the other (Austria and Spain) report on a voluntary basis. Only the Netherlands report MRSA from colonisation level onwards; the majority of countries (Austria, Germany, Spain, UK) only report bacteraemia (level III), which is the most serious consequence of infection and only present in a minority of cases. The UK, however, also screen for MRSA status prior to elective surgery, but this information is not officially reported. There is no consistent information about the "contagious burden", meaning the provision of information about colonisation and infections, from level I on where MRSA is contagious and can be passed to others [25].

Regulatory bodies

Regulatory bodies are built based on the political structure of the country where they are based. In Austria, Germany and Spain health care provision and management is in the responsibility of federal states or autonomous communities. The Netherlands and the United Kingdom follow a national approach.

Guidelines

The Netherlands has opted to pursue an active screening policy ("search & destroy"). Risk-based testing is in place in Austria, Germany, Spain and the UK, with the UK requiring screening of elective admissions to hospitals. Isolation practice for positive cases is basically the same in the five countries. However, the time lag between entering the hospital and being identified as MRSA carrier is critical as a variety of admission procedures, examinations and clinical investigations at the beginning of a hospital stay increase the likelihood to spread infectious diseases. The Netherlands, again, stand out by placing patients with an unknown MRSA status in isolation rooms; Spain places patients awaiting their results in isolation as well as, whenever possible (individual room availability), those who are previous carriers or high-risk patients (in one autonomous community Catalonia).

Healthcare workers in the four countries (Austria, Germany, Spain, UK) are not screened on a regular basis, meaning that those who are a high risk group in every countries' guidelines and

work where the contracting and spread of infectious disease occurs most readily are unaware of their own MRSA status [26]. The Netherlands screen staff regularly.

Implementation

All countries investigated have put legal obligations in place to implement their guidelines. However, only sporadic, if any, verifications and checks are being carried out.

Health policy

All the countries under investigation have increased their awareness for MRSA and have developed national action plans, regional and international networks of hospitals and laboratories, antibiotic stewardship, strengthened their legislation and created incentives to reduce the prevalence of MRSA [9].

Communication

Information and knowledge play a crucial role in the management of MRSA, and European health policy also puts special attention on communication. All five countries thus prioritise the provision of information to various target groups (health professionals, patients and general public).

	Austria	Germany	Netherlands	Spain (Catalonia – autonomous community/AC)	United Kingdom
Reporting Situation *Mandatory reporting* (frequency; Level I = Colonisation, Level II = Infection, level III = Bacteraemia) *Register*	**No mandatory reporting** - Voluntary basis for hospitals (level III) - Annual reporting of routine laboratory data (level III) - Only one federal states has a registry	**Mandatory**: Quarterly reporting of bacteraemia (level III) to the Robert Koch Institute (RKI) (since 07/2009) - Voluntary: Point prevalence information of infections (level II) - No information on colonization (level I)	**Mandatory** reporting of level I-III - Samples of bacteria strains (level I and II) sent to RIVM for classification	**No mandatory** reporting - Unified surveillance program (VINCat program): Annual collection of MRSA ratio, incidence and bacteraemia (level III) information	**Mandatory** weekly reporting of bacteraemia (level III) since April 2004 - Mandatory reporting of MRSA mortality
Regulatory bodies *Name* *Role*: Issue guidelines; control implementation	**Federal approach** - There is a basic national legal framework*, but each of the nine federal states has their own laws.	**Federal approach with national guidance** - RKI on national level. Health is in the responsibility of the 16 federal states, thus a commission has been	**National approach** -Ministry of Health, Welfare and Sports -Netherlands Institute for public health and the environment (RIVM)	**Regional approach** - Public Health Directorate in the Public Health Agency Hospital networks have established nosocomial	**National approach** **-** *England*: Care Quality Commission (CQC) as laid down by the Health and Social Care Act 2008; Foundation trusts have their

Impact	- Each Hospital develops its own infection control plan * Hospitals and Medical Institutions Act/Krankenanstalten- und Kuranstaltengesetz	established at the RKI representing the federal states (*Commission for Hospital hygiene and Preventions of Infections*/KRINKO). - German Society for Hospital Hygiene advises KRINKO - While KRINKO releases recommendations for the federal states, the German Protection Infection Act (IfSG) provides the legal framework for infection control in Germany on national level	-Health Council of the Netherland (GR) -The Health Care Inspectorate (IGZ) -The Dutch Working Party on Infection Prevention (WIP)	infection control programme (VINCat). - All regulations apply for regional level.	own independent regulator known as Monitor - *Scotland*: Social Care and Social Work Improvement Scotland (SCSWIS) and Healthcare Improvement Scotland (HIS) - *Wales*: Health Inspectorate for Wales (HIW), created in 2004, and the Care and Social Services Inspectorate for Wales (CSSIW) - *NI*: Regulation and Quality Improvement Authority (RQIA)
Guidelines *Basic principles*	**Guidelines**: Each hospital has its own guideline but all refer to the	**Guidelines**: German antibiotic resistance strategy (DART)	**Guidelines:** "Search and destroy" since 1986	**Guidelines**: Consensus Document: unify treatment of MRSA infection by a set of	**Guidelines**: The Health and Social Care Act (2008) Code of Practice for the NHS on the prevention and

	recommendations by Institute of Microbiology of Universities. **Principle** - risk-based testing of known or highly likely patients - Isolation after positive test results	KRINKO/RKI recommendations (Versions: 1999, 2005, 2011) **Principle** Risk-based testing of known or highly likely MRSA patients - Isolation when tested positive until three negative swaps - Barrier nursing for HCW - Interventions in MRSA patients should be restricted to those deemed absolutely necessary - No routine screening for patients or staff	**Principle** *Search*: Active screening of patients and staff *Destroy*: decolonisation and treatment based on guidelines developed by Dutch Working Party on Antibiotic Policy (SWAB) - Isolation based on risk assessment from first contact on	evidence based recommendations **Principle** - risk-based testing (nasal swabs) - Isolation for positive and waiting for results patients	control of healthcare associated infections: risk of infection posed to patients is kept to a minimum **Principle** - 10 registration criteria for the prevention and control, such as information, clean environment, identification of infected patients, isolation facilities - As of 2008 screening of high-risk cohorts, in particular A&E admissions and pre-operative surgical assessment patients - As of April 2009 all elective admissions must be screened for MRSA

Implementation *Routine Consequences*	**Legal obligation** for hospitals to implement measure to assure hygiene quality - Federal states carry out regular checks (differ among federal states)	**Legal obligation** for hospitals to implement measure to assure hygiene quality - Implementation has not been routinely controlled yet	**Legal obligation** for hospitals to implement measure to assure hygiene quality. - Implementation controlled by the Health Care Inspectorate	**Legal**: Infectious diseases committees are mandatory in the public network of hospitals in Catalonia - Implementation controlled by The Catalonian Health Department, throughout periodic accreditation processes	**Legal obligation**: Deadline for implementation no later than 2011 -Implementation assessed by the Care Quality Commission
Health Policy *National Action Plan* *Regional Networks* *Antibiotic Stewardship*	- Quality Committee to contribute to the development of quality management - Networks: National Reference Centre for Nosocomial Infections and Antibiotics Resistance - National Action Plan and a National Antimicrobial	- New Infection Protection Act regarding nosocomial infections (9 June 2011). The law is mandatory for all 16 Länder and the changes have to be implemented by 31 March 2012. **Key points:** - *Hygiene Commission ART*: a commission for "anti-infectiva resistance	The Dutch Working Party on Infection Prevention (WIP) *EUREGIO* Twente-Muensterland MRSA network *EurSafety Health Net*, MRSA networks for the Euroegio Meuse Rhine, Rhine-Meuse-Nord, Rhine-Waal, Gronau-Enschede, Ems-Dollert regio.	- Some quality indicators (prevalence of nosocomial infection) are incorporated into incentive policies among professionals as part of the "*Management by Objectives*" approach. Actors involved in MRSA policies are: local infection control committees, infection control nurse, consultant in infectious diseases,	Health Protection Agency - collects routine surveillance data on infection rates, provides training and specialist advice on ways to deal with infections - acts as a conduit for the sharing of information between providers. - works with the general public to ensure key information on the threats

	Strategy is currently being developed - Antibiotic Stewardship European Networks	and therapy" (ART) is to be established with diagnostic and treatment list - *Joint Federal Committee* "Gemeinsamer Bundesausschuss" releases guidelines to hygiene and quality management - Sanitation: The outpatient sanitation of MRSA patients should be reimbursed better for GPs to motivate them to follow up the treatment of MRSA outpatients. - Strong hospital network especially in cross border regions, e.g. *EUREGIO* Twente/Münsterland		microbiologist and clinical staff	posed by infections is easily accessible

Explicit communication Information policy Key messages	- Each hospital creates their own guidelines, adapted to their specific circumstances and based on the hygiene regulations enshrined by law and the recommendations published by the responsible scientific institutions at universities - Dissemination of information for patients and visitors in an ad-hoc way - In general, little media attention regarding MRSA	KRINKO guidelines point out that information and communication is key to successfully respond to the health threat posed by MRSA - Information and communication needs have not been investigated or recommended in the new guidelines	- Information is available at hospitals and nursing homes - Information for the general public, hospital staff and policy makers about MRSA is available through the MRSA network described above	- Information available for health professionals, patients and general public	- Two of the ten criteria in the Code of Practice for the NHS on the prevention and control of healthcare associated infections relate specifically to the provision of information - Despite the laws and effort surrounding improving information the results have been mixed.

Table 2: Overview of results in five EU countries

Discussion

We first comment the results of the five countries, then discuss the epidemiological rationale and the implication for risk communication.

Situation in the five countries

Reporting

Comprehensive data on prevalence is difficult to obtain as most mandatory and voluntary surveillance systems were found to only cover MRSA bacteraemia. Point prevalence studies and surveys that have attempted to capture the situation have also been based on information provided by hospitals on a voluntary basis. This has contributed to the sporadic nature of evidence around MRSA and thus current data does not appropriately reflect the ubiquitous nature of the treat of infection [3].

Moving the reporting downstream with the reporting of bacteraemia, level III, is posited to be one way to keep the absolute numbers down. In regards to communication, this contributes to keeping perception of infection rates artificially low. This could be appealing to policy makers as the small numbers reported cause less concern than if the prevalence of infection were to be revealed [27-29]. It is, however, only an artefact of the reporting – and not reflective of the underlying epidemiology of the infectious disease.

Regulatory bodies

Having different regulatory bodies could possibly lead to variability in terms of guidelines and recommendations and their implementation. The variability of recommendations within and across countries could contribute to the perception of inconsistency.

Guidelines

The rigor of infection control is not appropriately reflected in the guidelines: MRSA patients are constantly contagious and not only after identification; healthcare workers fall under the risk groups for screening in every country, but are, with the exception of the Netherlands, not screened.

Implementation

Concerns about the implementation of the guidelines are frequently raised. Surveys from Germany and the UK support these findings. The authors showed that a minority of the hospitals have consistently implemented guidelines [30-31].

Health policy

The consistent adoption of policy in the guidelines and the implementation into the daily practice is, however, subject to discussion. The gap between the policy and its implementation is not just a medical problem, but also influences the perception of health risks, and could affect compliance with the intended behaviour [32].

Communication

The explicit information strategy is only one aspect of communication ("voluntary communication"); another aspect is how messages that are expressed in the official statements are 'executed' on the ground of the daily reality of health care ("autonomous communication"). Infection control measures, their implementation into the medical environment and their frictions are tacit acts of communication yet little attention has been spent on how to monitor and improve the way they contribute to the conveyance of key health messages.

Epidemiological rationale

Infection control approach

There are, generally speaking, two basic strategies for responding to infectious diseases that emerge from the analysis: a 'specific' and a 'general' approach.

The specific approach relies on the identification of those patients already infected with MRSA. Once an MRSA patient is identified and known ('red flagged'), appropriate measures can be taken. These measures range from sanitation of skin colonisation and/or treatment of the infection. The patient should also be isolated from the hospital environment in order to prevent the transmission of the pathogen. Once an MRSA patient has been identified, health care workers have to wear personal protection equipment and apply stringent hygiene measures. The MRSA patient's room is often labelled with a sign signalling the contagious status. There is a general consensus regarding isolation and hygiene practices. However, the crucial choice of strategy for identification in the specific approach is controversial. Only the Netherlands has a pro-active screening policy; all of the other countries studied used a process of reactive

screening based on risk assessment, with the UK also requiring pre-hospital screening for elective admissions. Hospitals across the four 'reactive' EU countries (Austria, Germany, Spain, UK) appear very reluctant to screen patients for a number of reasons. One is that the care for and treatment of MRSA patients places greater demands on the attending nurses and clinicians, meaning that there could be an incentive to avoid correct MRSA classification. Additional measures such as spatial requirements (single isolation rooms), differential treatment guidelines, and consequences for staff and ward routines aggravate the situation. Also at the hospital level it ostensibly requires more time and resources to care for MRSA patients and therefore those facing budgetary pressure may possibly be more inclined to avoid diagnosis, despite the fact that the costs of cases progressing to bacteraemia may outweigh the costs of an active screening policy [33-37].

If contagious patients are not identified, a 'general' approach with stringent measures to guarantee good hygiene has to be adhered to by all healthcare workers, patients and visitors. This system of infection control includes, among others, requirements such as strict hand hygiene, regular cleaning and disinfection of surfaces. To promote the general hygiene approach good communication is crucial to ensure that everyone is aware of what they need to do in order to avoid infection and stop further spread. Frictions between infection management and communication could affect the adoption of the recommended behaviour.

Ethical Problems

The handling for MRSA patients raises some ethical questions regarding whether there is equal treatment of isolated and contagious patients. The restriction of physical transport and transfer forms part of the infection control recommendations in the European countries investigated. However, it is an increasingly controversial and sensitive aspect of the prescribed treatment of MRSA patients as many feel it could compromise the quality of clinical care [38]. Most guidelines recommend that some invasive interventions be confined to the room used by MRSA patients [39]. In the case where interventions performed in the patient's room would be better carried out elsewhere, the lack of an optimal environment could lead to reduced performance on the part of clinicians. Infectious patients are put at the end of the day's surgery schedule and are more likely to be postponed due to emergencies in the surgical programme. The

avoidance of invasive diagnostics alongside being the “last operation on the schedule” could comprise the medical treatment of an often critically ill patient.

Organisational Aspects

MRSA is also an occupational health problem. Healthcare workers are not routinely screened for MRSA colonisation or infection - apart from in the Netherlands. This reluctance to identify infectious staff could be seen in the context of healthcare organisation. If a staff member is colonised with MRSA they are not allowed to work in their usual locations. This poses a burden to the workplace organisation in terms of the potential for inconsistent labour supply, in particular in an already overstretched working environment. Hospitals and countries in which the intensive care unit (ICU) carer/nurse to patient ratio is 1:1 report basically no problems of nosocomial infections [40]. This adds weight to the hypothesis that a major contributor to increasing prevalence of MRSA is the high patient-healthcare worker-ratio [41].

Architecture

The guidelines also point out the importance of spatial distancing and the role of architecture – a challenge which has not been met by modern hospitals and it remains unclear whether this concern regarding the spread of infectious disease will be met in the future [6].

Risk communication strategy

The ‘general’ approach i.e. the basic tools for fighting an infectious disease epidemic, all feature prominently in all national guidelines: knowledge, training, information, networks and collaboration. But the question remains of how well are the recommendations implemented at the provider levels especially in terms of their risk communication practices.

Conflicting messages

From a patient perspective, the discharge of MRSA patients is an ostensibly incongruent routine. After being treated in strict isolation and under a stringent hygiene regimen – patients are simply discharged and informed that MRSA is no risk for healthy people [42]. This dissonance could lead to confusion and distress for patients, relatives and visitors and adds further to potential misperceptions of their health risk to others.

Knowledge

Despite the laws and efforts surrounding improving information and communication, knowledge levels have been mixed. The lack of knowledge in healthcare professionals is seen as an influencing factor for increasing prevalence of nosocomial infections [43-46].

Risk communication policy

The risk communication policies of the five EU countries were found to contain only information relating to risks faced by people directly involved in healthcare, such as hospital staff and patients. These policies were based on the same risk assessment that is used to determine which patients should be screened for MRSA. It focuses on healthcare workers, long term care, chronically ill patients and patients facing surgery. There has only been little effort to address MRSA as problem in and for the general population [47]. This narrow view is congruent with the lack of concern for the role of other factors, such as behaviour, implementation of guidelines, etc., seen in other areas.

Media Coverage

The consensus in the literature is that the UK media coverage, especially within the tabloid newspapers, has been at times sensationalist. However, the pressure placed on governments in response to the extensive media coverage has played a significant role in a number of policy changes which have contributed to the decline in incidence of deaths and bacteraemia associated with MRSA [48-49].

Public Perception

The infection threat posed by MRSA is difficult to communicate. Researchers have blamed contradicting risk communication about necessary hygienic measures as one problem [50]. They see that even necessary cleaning routines have not been implemented in hygiene plans [50]. More importantly, risk communication messages might have influenced the risk perception of healthcare workers, patients and the public inappropriately. The message that MRSA is not an infectious diseases agent which can lead to outbreaks outside of healthcare facilities and also does not do harm to family members has direct consequences for the epidemiology of MRSA, and could in turn have led to the perception that MRSA is a harmless pathogen only affecting those who are already ill [42].

Summary

The data situation in the countries is patchy at best, and thus it is difficult to offer up any firm conclusions regarding the overall burden of disease in the countries studied. What is clear, however, is that knowledge and information about the infectious disease burden is limited in the general population, and this lack of clarity has led to a growth in misconceptions surrounding the threat of MRSA.

The variability of recommendations within, and across, countries could be contributing to the perception of inconsistency and therefore this should be looked, potentially as part of a wider strategy designed to improve risk communication. Having inconsistent guidelines and practices in place may also be affecting the level at which recommended behaviours are adopted. This is an area that would require more research.

The risk communication of MRSA has several weaknesses: there are misleading messages in the official statements and a gap between the official communications and guidelines, with inconsistent adoption of the latter at the provider level.
This discrepancy between the official, explicit health messages around MRSA and the implicit messages stemming from the performance of infection control measures should therefore be a key target for those wishing to improve the accuracy of perceptions regarding the health risks of MRSA.

Recommendation

The increasing burden of antimicrobial resistance and health care associated infections has been reflected in growing public awareness, for example with major health policy organisations urging countries to improve their risk communication and MRSA prevention strategies. These ought to be revised to also address the general public. Thus far, most countries have adopted a universal risk-based approach addressing affected groups, without differentiating between groups, or addressing the wider public. Health policy and practice has also focused on individual infection control measures and place the majority of responsibility on the individual. Organizational aspects (patient/healthcare worker ratios, architecture, etc.) have not been prominently discussed. The rational use of antibiotics and antibiotic stewardship is a significant move designed to place greater responsibility for the control of HCAIs on medical

professionals. However, the key message, often included in national risk communication strategies, that MRSA is a problem only for those who are already ill, is misleading. In fact, MRSA is a problem affecting society as a whole. MRSA is a problem for healthy people as they can transmit the disease; MRSA is a problem for treating too many patients in too narrow spaces. MRSA is a problem because MRSA patients are only reluctantly identified. And finally, MRSA is a problem because the explicit and implicit messages of MRSA are often inconsistent if not contradictory.
The problem of health care related infections and antimicrobial resistance can only be tackled in a more holistic approach regarding reconsideration of affected groups, healthcare organisation, architecture and a rational use of antibiotics – and by revising a risk communication strategy accordingly.

Declaration of interests: All authors declare that they have no conflicts of interests.

Ethics: No ethics approval or consents from patients or participants were sought as this is an analysis of published literature and health policies. No confidential information was disclosed.

Contributions of authors: PD developed the concept, provided the information from Germany, drafted the manuscript and oversaw the project. SK, provided information from the UK and contributed to the discussion and the manuscript writing; ND provided information from the Netherlands and contributed to the discussion and the manuscript writing; AS and CP provided information from Austria and contributed to the discussion and the manuscript writing; SAB and JG provided information from Spain and contributed to the discussion and the manuscript writing. All authors approve the final version of the manuscript.

Data availability: all data used is provided in the tables.

Acknowledgement: This research was funded by European Commission 7th Framework Programme (FP7 – 2007-2013) under Grant Agreement 242058, EUCBB (European Union Cross Border Care Collaboration).

Literature

1. Kock R, Becker K, Cookson B, van Gemert-Pijnen JE, Harbarth S, Kluytmans J, et al. Methicillin-resistant Staphylococcus aureus (MRSA): burden of disease and control challenges in Europe. Euro surveillance : bulletin europeen sur les maladies transmissibles = European communicable disease bulletin. 2010;15(41):19688.

2. Tiemersma EW, Bronzwaer SL, Lyytikainen O, Degener JE, Schrijnemakers P, Bruinsma N, et al. Methicillin-resistant Staphylococcus aureus in Europe, 1999-2002. Emerg Infect Dis. 2004;10(9):1627-34.

3. Dulon M, Haamann F, Peters C, Schablon A, Nienhaus A. MRSA prevalence in european healthcare settings: a review. BMC Infect Dis. 2011;11:138.

4. Borg MA, Camilleri L, Waisfisz B. Understanding the epidemiology of MRSA in Europe: do we need to think outside the box? The Journal of hospital infection. 2012;81(4):251-6.

5. Kramer A, Wagenvoort H, Ahren C, Daniels-Haardt I, Hartemann P, Kobayashi H, et al. Epidemiology of MRSA and current strategies in Europe and Japan. GMS Krankenhaushygiene interdisziplinar. 2010;5(1):Doc01.

6. Wilson AP, Ridgway GL. Reducing hospital-acquired infection by design: the new University College London Hospital. The Journal of hospital infection. 2006;62(3):264-9.

7. Schwab F, Meyer E, Geffers C, Gastmeier P. Understaffing, overcrowding, inappropriate nurse:ventilated patient ratio and nosocomial infections: which parameter is the best reflection of deficits? The Journal of hospital infection. 2012;80(2):133-9.

8. Hulscher ME, Grol RP, van der Meer JW. Antibiotic prescribing in hospitals: a social and behavioural scientific approach. The Lancet infectious diseases. 2010;10(3):167-75.

9. Bruce J, MacKenzie FM, Cookson B, Mollison J, van der Meer JW, Krcmery V, et al. Antibiotic stewardship and consumption: findings from a pan-European hospital study. J Antimicrob Chemother. 2009;64(4):853-60.

10. Lesprit P, Brun-Buisson C. Hospital antibiotic stewardship. Current opinion in infectious diseases. 2008;21(4):344-9.

11. Bajardi P, Poletto C, Ramasco JJ, Tizzoni M, Colizza V, Vespignani A. Human mobility networks, travel restrictions, and the global spread of 2009 H1N1 pandemic. PloS one. 2011;6(1):e16591.

12. Kock R, Brakensiek L, Mellmann A, Kipp F, Henderikx M, Harmsen D, et al. Cross-border comparison of the admission prevalence and clonal structure of meticillin-resistant Staphylococcus aureus. The Journal of hospital infection. 2009;71(4):320-6.
13. Daniels-Haardt I, Verhoeven F, Mellmann A, Hendrix MG, Gemert-Pijnen JE, Friedrich AW. [EUREGIO-projekt MRSA-net Twente/Munsterland. Creation of a regional network to combat MRSA]. Gesundheitswesen. 2006;68(11):674-8.
14. Friedrich AW, Daniels-Haardt I, Kock R, Verhoeven F, Mellmann A, Harmsen D, et al. EUREGIO MRSA-net Twente/Munsterland--a Dutch-German cross-border network for the prevention and control of infections caused by methicillin-resistant Staphylococcus aureus. Euro Surveill. 2008;13(35).
15. European Union. Antimicrobial resistance. Special Eurobarometer 445 – April 2016.
http://ec.europa.eu/COMMFrontOffice/publicopinion/index.cfm/Survey/getSurveyDetail/search/Antimicrobial%20resistance/surveyKy/2107 (assessed 24 October 2016)
16. Chief Medical Officer. Infections and the rise of antimicrobial resistance: Department of Health, UK; 2013 [cited 13.03.2016]. Available from: http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/138331/CMO_Annual_Report_Volume_2_2011.pdf.
17. ECDC. Antimicrobial Resistance and Healthcare-associated Infections Programme 2013 [13.03.2016]. Available from: http://ecdc.europa.eu/en/activities/diseaseprogrammes/ARHAI/Pages/index.aspx.
18. ECDC. ECDC Key document: Health Communication Strategy 2010-2013 2010 [13.03.2016]. Available from: http://ecdc.europa.eu/en/aboutus/KeyDocuments/0911_KD_ECDC_Health_Communication_Strategy_2010_013.pdf
19. Rogers MB, Amlot R, Rubin GJ. The impact of communication materials on public responses to a radiological dispersal device (RDD) attack. Biosecurity and bioterrorism : biodefense strategy, practice, and science. 2013;11(1):49-58.
20. Verhoeven F, Steehouder MF, Hendrix RM, van Gemert-Pijnen JE. How nurses seek and evaluate clinical guidelines on the Internet. J Adv Nurs. 2010;66(1):114-27.
21. Rubin GJ, Page L, Morgan O, Pinder RJ, Riley P, Hatch S, et al. Public information needs after the poisoning of Alexander Litvinenko with polonium-210 in London: cross sectional telephone survey and qualitative analysis. BMJ. 2007;335(7630):1143.

22. Berendsen AJ, de Jong GM, Schuling J, Bosveld HE, de Waal MW, Mitchell GK, et al. Patient's need for choice and information across the interface between primary and secondary care: a survey. Patient Educ Couns. 2010;79(1):100-5.
23. Washer P, Joffe H, Solberg C. Audience readings of media messages about MRSA. The Journal of hospital infection. 2008;70(1):42-7.
24. Hoogervorst J, van der Flier H, Koopman P. Implicit communication in organisations. Journal of Managerial Psychology. 2004;19(3):288-311.
25. Coia JE, Leanord AT, Reilly J. Screening for meticillin resistant Staphylococcus aureus (MRSA): who, when, and how? BMJ. 2014;348:g1697.
26. Brady RR, McDermott C, Graham C, Harrison EM, Eunson G, Fraise AP, et al. A prevalence screen of MRSA nasal colonisation amongst UK doctors in a non-clinical environment. Eur J Clin Microbiol Infect Dis. 2009;28(8):991-5.
27. Wegwarth O, Gaissmaier W, Gigerenzer G. Deceiving numbers: survival rates and their impact on doctors' risk communication. Medical decision making : an international journal of the Society for Medical Decision Making. 2011;31(3):386-94.
28. Gaissmaier W, Wegwarth O, Skopec D, Muller AS, Broschinski S, Politi MC. Numbers can be worth a thousand pictures: individual differences in understanding graphical and numerical representations of health-related information. Health psychology : official journal of the Division of Health Psychology, American Psychological Association. 2012;31(3):286-96.
29. Gigerenzer G, Wegwarth O. Five year survival rates can mislead. BMJ. 2013;346:f548.
30. RKI. Der Umgang mit MRSA Patienten in deutschen Krankenhäusern. Epidemiologisches Bulletin. 2011;2011(15):119-21.
31. Fuller C, Robotham J, Savage J, Hopkins S, Deeny SR, Stone S, et al. The national one week prevalence audit of universal meticillin-resistant Staphylococcus aureus (MRSA) admission screening 2012. PloS one. 2013;8(9):e74219.
32. Rubin GJ, Amlot R, Page L, Wessely S. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross sectional telephone survey. BMJ. 2009;339:b2651.
33. Coia JE, Duckworth GJ, Edwards DI, Farrington M, Fry C, Humphreys H, et al. Guidelines for the control and prevention of meticillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities. The Journal of hospital infection. 2006;63 Suppl 1:S1-44.

34. Diller R, Sonntag AK, Mellmann A, Grevener K, Senninger N, Kipp F, et al. Evidence for cost reduction based on pre-admission MRSA screening in general surgery. Int J Hyg Environ Health. 2008;211(1-2):205-12.
35. Wernitz MH, Keck S, Swidsinski S, Schulz S, Veit SK. Cost analysis of a hospital-wide selective screening programme for methicillin-resistant Staphylococcus aureus (MRSA) carriers in the context of diagnosis related groups (DRG) payment. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases. 2005;11(6):466-71.
36. Wernitz MH, Swidsinski S, Weist K, Sohr D, Witte W, Franke KP, et al. Effectiveness of a hospital-wide selective screening programme for methicillin-resistant Staphylococcus aureus (MRSA) carriers at hospital admission to prevent hospital-acquired MRSA infections. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases. 2005;11(6):457-65.
37. van Rijen MM, Kluytmans JA. Costs and benefits of the MRSA Search and Destroy policy in a Dutch hospital. Eur J Clin Microbiol Infect Dis. 2009;28(10):1245-52.
38. Bukki J, Klein J, But L, Montag T, Wenchel HM, Voltz R, et al. Methicillin-resistant Staphylococcus aureus (MRSA) management in palliative care units and hospices in Germany: a nationwide survey on patient isolation policies and quality of life. Palliative medicine. 2013;27(1):84-90.
39. RKI. Empfehlung zur Prävention und Kontrolle von Methillicin-resistenten Staphylococcus aureus-Stämmen (MRSA) in Krankenhäusern und anderen medizinischen Einrichtungen. Mitteilung der Kommission für Krankenhaushygiene und Infektionsprävention am RKI. Bundesgesundheitsblatt - Gesundheitsforschung - Gesundheitsschutz. 1999;42(12):954-8.
40. Assadian O, Toma CD, Rowley SD. Implications of staffing ratios and workload limitations on healthcare-associated infections and the quality of patient care. Critical care medicine. 2007;35(1):296-8.
41. Daud-Gallotti RM, Costa SF, Guimaraes T, Padilha KG, Inoue EN, Vasconcelos TN, et al. Nursing workload as a risk factor for healthcare associated infections in ICU: a prospective study. PloS one. 2012;7(12):e52342.
42. HPA. MRSA - Information for patients: Health Protection Agency (HPA); 2010 [13.03.2016]. Available from:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/330925/MRSA_information_for_patients.pdf

40. Easton PM, Sarma A, Williams FL, Marwick CA, Phillips G, Nathwani D. Infection control and management of MRSA: assessing the knowledge of staff in an acute hospital setting. The Journal of hospital infection. 2007;66(1):29-33.

41. Horner C, Wilcox M, Barr B, Hall D, Hodgson G, Parnell P, et al. The longitudinal prevalence of MRSA in care home residents and the effectiveness of improving infection prevention knowledge and practice on colonisation using a stepped wedge study design. BMJ open. 2012;2(1):e000423.

42. Schaffer K, Fitzgerald SF, Flynn A, Fitzpatrick F, Fenelon LE. Newly qualified doctors' knowledge about MRSA: uncertainty regarding management in the community. The Journal of hospital infection. 2007;66(2):190-2.

43. Seaton RA, Montazeri AH. Medical staff knowledge about MRSA colonization and infection in acute hospitals. The Journal of hospital infection. 2006;64(3):297-9.

44. Ferry T, Etienne J. Community acquired MRSA in Europe. BMJ. 2007;335(7627):947-8.

45. Boyce T, Murray E, Holmes A. What are the drivers of the UK media coverage of meticillin-resistant Staphylococcus aureus, the inter-relationships and relative influences? The Journal of hospital infection. 2009;73(4):400-7.

46. Brown B, Crawford P. 'Post antibiotic apocalypse': discourses of mutation in narratives of MRSA. Sociology of health & illness. 2009;31(4):508-24.

47. Simon AE, Martin; Kramer, Axel; Engelhart, Stefan. Umsetzung der MRSA-Empfehlungen der KRIINKO von 1999 - Aktuelle Hinweise des Vorstandes des DGKH. Hyg Med. 2009;34(3):90-101.

III. Strategy for risk communication governance in public health

BIOLOGICAL RISKS TO PUBLIC HEALTH – lessons from an international conference to inform the development of national risk communication strategies

Report of an international conference on risk communication strategies before, during and after public health emergencies, Rabat, Morocco, 22-23 October 2015[21]

Abstract

Biological risk management in public health focuses on the impact of outbreaks on health, economy and other systems and ensuring biosafety and biosecurity. To address this broad range of risks, the International Health Regulations (IHR 2005) request from all member states to build defined core capacities, risk communication being one of them. While there is existing guidance on the communication process and on what health authorities need to consider to design risk communication strategies that meet the requirements on a governance level, little is done on implementation due to a number of factors including lack of resources (human, financial and others), and systems to support effective and consistent capacity for risk communication. The international conference on "*Risk communication strategies before, during and after public health emergencies"* provided a platform to present current strategies, facilitate learning from recent outbreaks of infectious diseases and to discuss recommendations to inform risk communication strategy development. The discussion concluded four key areas of improvements in risk communication: consider communication as a multidimensional process in risk communication, broaden the biomedical paradigm by integrating social science intelligence into epidemiological risk assessments, strengthen multisectoral collaboration including with local organizations, and spearhead changes in own organisations for better risk communication governance. National strategies should design risk communication to be proactive, participatory, multisectoral, facilitating the connection between sectors and strengthening collaboration.

[21] Petra Dickmann, Aphaluck Bhatiasevi, Fadela Chaib, Ombretta Baggio, Christina Banluta, Lilian Hollenweger and Abderrahmane Maaroufi (2016): Biological risks to public health - lessons from an international conference to inform the development of risk communication strategies. Health Security 14(6):433-440.

REPRINT WITH GENEROUS PERMISSION OF HEALTH SECURITY.

Keywords: Risk communication, Governance, Public health preparedness, Biosafety/Biosecurity, International Health Regulations (IHR 2005)

Introduction

Background

Biological risks pose challenges to public health. These risks can be naturally occurring disease outbreaks at national and international levels, accidental exposure to pathogens in the context of biomedical diagnostics and research or intentional use of pathogens for harmful purposes. Biological risk management focuses on these following three areas of:

iv) The preparedness for the impact of naturally occurring disease outbreaks on national or international scale on individual and public health, national and international economy, social and other systems;

v) *Biosafety* as understood by the UN as "*principles, technologies, practices and measures implemented to prevent the accidental release of, or unintentional exposure to pathogenic agents*."[1]

vi) *Biosecurity* which refers to the "*protection, control and accountability measures implemented to prevent the loss, theft, misuse, diversion or intentional release of pathogenic agents and related resources as well as unauthorized access to, retention or transfer of such material*."[1]

The World Health Organization has recognised the importance of biological risks to public health and has updated its International Health Regulations (IHR) in 2005 to ensure that all member states build their capacities to prevent, detect, respond to and recover from biological and other defined risks to public health and ensure to minimise the impact on trade and travel (IHR 2005).[2]

Public health authorities have worked on technical areas to mitigate biological risks, such as improving disease surveillance systems and laboratory capacities.[3] The IHR (2005) also stress the importance of risk governance in the management of public health events and has broadened the understanding of risk communication as a core capacity under the IHR (2005). While in a conventional understanding risk communication was seen as a technical process to inform the public what to do in times of a health crisis, the current understanding of risk communication is defined by the WHO as "*a multi-level and multi-faceted process, which aims to help stakeholders define risks, identify*

hazards, assess vulnerabilities and promote community resilience, thereby promoting the capacity to cope with an unfolding public health emergency."[4] This broader understanding of risk communication moves beyond a common understanding that limits risk communication to a timely conveyance of information about health risks to a public. It considers risk communication not as a technical expertise in communication but rather as a strategic activity supporting the management of public health risks by bringing in social science expertise. This transformation process, thus, requires from national public health agencies to re-think their current risk communication strategies and plans. Addressing this new challenge, national public health agencies have little guidance in developing their national risk communication strategies. There is some evidence on how to improve the communication process in a crisis[5-7] or for particular situations, e.g. public health emergencies[8], high security laboratories[9], during an Influenza pandemic[10] or more generically to evaluate biosafety and biosecurity from a risk communication perspective[11]. There is also a growing body of literature that elicits the information needs of the general public, e.g. after biosecurity events[12,13] or infectious disease outbreaks[14] or particular at-risk groups. While these are very helpful in meeting specific communication requirements they mostly focus on the information needs of the public and thus remain in the conventional understanding of risk communication as the timely conveyance of information from experts to a lay population.

But what are the institutional and strategic steps public health authorities need to take to ensure the multi-level, multifaceted process of risk communication at an organisational level – what do public health authorities need to do and consider when developing risk communication strategies?

To tackle this question, an international high-level conference on "*risk communication strategies before, during and after public health emergencies*" was held in Rabat, Morocco, on 22-23 October 2015, which was organised within the framework of the German Partnership Program for Excellence in Biological and Health Security financed by the German Federal Foreign Office. The conference provided a platform to present current risk communication strategies, learn from recent outbreaks of infectious diseases, particularly the Ebola virus disease, and to discuss recommendations with an international audience. This article summarises the presentations and discussions from the conference and concludes with recommendations that inform the development of national risk communication strategies in Morocco and Tunisia.

Conference

The high-level conference was organised by the Directorate for Epidemiology (DELM) within the Moroccan Ministry of Health, together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, and aimed to inform a project that supports the Moroccan and Tunisian Ministries of Health in the development of national risk communication strategies. The conference was attended by key stakeholders from Morocco, Tunisia and Sudan and featured contributions from international experts and partners (WHO HQ, EMRO, and country office, International Federation of the Red Cross and Red Crescent Societies (IFRC), GIZ, Robert Koch Institute (RKI), international airports).

The conference followed the logical sequence of introducing the international legislative framework (IHR and Public Health Emergencies of International Concern (PHEIC)), eliciting learnings from a recent PHEIC (the Ebola outbreak in in West Africa), including the anthropological perspective from West Africa, learning from a national outbreak (Shiga toxin-producing *E. coli* (STEC) in Germany) and international airports (Casablanca and Frankfurt) as points of entry in order to stimulate thinking and discussion on risk communication strategies. A concluding panel discussed and summarised key recommendations.

International legislative framework – lessons from the Ebola outbreak in West Africa

The International Health Regulations (IHR 2005) provide the legislative framework for Member States to build and strengthen the eight core capacities, risk communication being one of them. Member state assess their capacities annually using an IHR self-assessment monitoring framework and report their assessment to WHO. More recently, the Global Health Security Agenda (GHSA), together with international partners such as WHO, have developed a Joint External Evaluation tool (JEE) to map and assess the strengths and weaknesses in countries' ability to prevent, detect and respond to infectious disease outbreaks in a collaborative approach using countries' self assessment with an assessment by external experts to result in a joint evaluation of IHR capacities.[15]

Public health events that can pose a threat to the international public health can be declared under the IHR as Public Health Emergencies of International Concern (PHEIC). The WHO Director General is in the position to declare a PHEIC following

the convening of an emergency committee of experts (IHR emergency committee). The declaration of a PHEIC facilitates international coordination and collaboration to respond to and mitigate the impact of this public health emergency. The Ebola outbreak in West Africa provided some opportunities to improve risk communication and WHO shared their reflections to inform the development of risk communication strategies:

The ***East Mediterranean Regional Office*** (EMRO) of WHO reported on a comprehensive assessment requested by the World Health Assembly in 2015 to evaluate the capacities and capabilities of EMRO region in prevention of and response to a potential importation of Ebola virus disease into the region. This assessment identified a number of critical gaps: limited capacity for prevention, detection and response in the areas of leadership and coordination, surveillance, infection prevention and control, risk communication, points of entry, and laboratory diagnosis. The survey revealed that risk communication was not considered essential, few had communication plans and countries even voiced their reluctance to communicate as they felt it would create panic among the population. These results underlined the need for awareness raising and training to build a common understanding in the group of health professionals and to support the development of communication strategies and plans. This assessment also revealed a discrepancy between this Ebola assessment and the IHR assessment outcome that countries report to WHO and reinforces the findings of the IHR monitoring review to strengthen the IHR assessment tools from self-assessment to peer review and the Joint External Evaluation (JEE) tool.[15-16]

WHO HQ reflected on the communication and coordination during the Ebola outbreak. The key learning was that "*dissemination of information alone is useless and sometimes dangerous. We must listen and constantly adjust our strategies and approaches on the basis of people's concerns*." Starting point for the risk communication process is the perception of risks in the communities which is often different from the scientific assessment of risks. In order to gather and understand communities' perception, interactions and engagement are necessary. This relationship building with communities is one of the key risk communication activities. Providing technical information is only one of the building blocks, along with values, credibility, expression of caring and most importantly trust. Trust is a key enabling factor for relationship building and engaging with communities. The IHR (2005) as legal framework to build and strengthen the capacity in risk communication provides the context and justification to start building relationships with communities before, during and after outbreaks.

At the height of the Ebola outbreak, many responders and stakeholders were already on the ground and coordination proved challenging. The collaboration with international partners, but in particular the communication with local communities provided opportunities for key insights: the dissemination of information alone (scientific facts) is not sufficient to build the relationship with local communities. In fact, a relationship and a solid degree of trust are imperative to collaborate on response and mitigation strategies and important parts of risk communication strategies that need to be integrated into the risk management process.

The example of key messages on prevention and response revealed, once again, the gap between scientific risk assessments and the public perception of risks. The scientific advice to wash hands regularly or to not touch a sick person conflicted with social realities and cultural practices in affected communities. This scientific advice was simply not applicable and integrate-able into local realities and mind sets and even offended people. To not touch a sick person was considered in communities as unacceptable practice. This advice, though, resulted in communities to disbelief, growing distrust and even aggression towards to international and national health professionals. Messages have to be re-framed to make sense for the public. This is a process that should be informed by the scientific assessment as one source among others, such as social anthropology, psychology, etc. The community resistance to official health advice and rumours are in fact other important sources of information where risk communication has gone wrong. WHO HQ gave an example of the re-labelling of an Ebola Isolation Centre into an Ebola Treatment Centre which helped the community to gain trust into the health facility. Rumours are in particular indicative for the strength and weakness of the current risk communication process: rumours need to be captured and deconstructed in order to improve the relation between health workers and communities. The rumour, for example, that there was trade of body parts and blood was understood as a lack of trust in the health system. In a collaborative analysis of this rumour, WHO partnering with health workers and community influencers have reconceptualised this lack of trust. Together they reframed the approach and stressed the importance of body integrity and working with health workers and community influencers as part of the communities.

The biggest learning point for WHO was, however, the extent of community engagement and understanding communities in order to establish relevant risk

communication activities. Being close, listening and responding to community's concern is an approach now adopted more prominently in international organisations.

WHO Communications: Communications is an integral part of public health response and serves multiple purposes: people have the legal right to be informed about risks and how to protect themselves. The aim of communications is to enable the public for decision-making on risk reducing behaviours. It is therefore essential to work with the media at all levels - the local, national and international, as they are quick, have a broad geographic coverage, are influential and often cost effective. The WHO approach to communications during outbreak situations is characterised by five principles: trust, early announcement, transparency, listening (surveillance) and planning. "*Showing the work - shaping the narrative*" and the use of new information technology is the paradigm of WHO that aims at rendering communications more proactive and transparent. This requires coordination between technical areas, understandable messages, and community engagement embedded in a listening approach. In examples from Liberia in 2014 WHO demonstrated three phases of their communication approach which illustrates the inner-organisational learning: in the initial phase they applied a crisis communication strategy building on the rationale of past experiences of Ebola in outbreaks in remote settings with a 90% death rate. The key messages at this early stage were that "Ebola kills", Ebola has no cure and that bush meat consumption spread the disease. These key messages were distributed via mass media, posters and radio and resulted in denial: the perception was that Ebola spread in remote areas and when people don't eat bush meat they won't contract the disease. It also led to sick people staying (and dying) at home as the message was that there is no cure and no treatment for Ebola. In a second phase the risk communication strategy moved to awareness-raising under the rationale that Ebola spread in major cities, but with increasing survival rates. The key messages in this second phase were that "Ebola is real", there are signs and symptoms to watch that can be treated and a hotline to call for transport to treatment centres. The interventions broadened from mass media to include campaign mode using town criers and loud speakers on trucks and motorbikes. The outcomes of this awareness-raising strategy was that the demands from the public quickly exceeded response capacities and led to a lack of confidence and trust in existing structures. In a third phase the risk communication strategy applied community engagement with the rationale that communities are part of the solution. The key messages were to avoid unprotected contact with dead bodies, that early treatment

increases survival rates and to de-stigmatise survivors. The communication interventions were more interpersonal with community meetings and trainings. The outcomes of this approach were that community influencers are part of the response and need for more decentralised, localised communication. The three stages of risk communication approaches during the response to Ebola were incorporated in a lessons-learned process in WHO that resulted in giving more importance to community engagement and listening approaches in risk communication.

The ***International Federation of Red Cross and Red Crescent Societies*** (*IFRC)* presented the steep learning curve that the organisation made during its response to the outbreak. IFRC interventions in the affected region had a focus on community communication and engagement as the people on the ground are the drivers of the disease: they can spread or stop the outbreak. Respecting local cultures, understanding their information needs, building trust and taking time to build relationship by introducing its staff as reliable partners in a joint process of change was at the core of the IFRC approach. In addition, using new technology to improve the two-way communication between authorities and communities and generating data on perception, beliefs as well as rumours were key activities to inform and shape the community engagement strategy. There was a shift in the organisation in regards to the perception of rumours: rather than fighting misinformation, rumours were seen as important sources where more collaboration was needed. Rumours about organ trading, cannibalism and mutilation of dead bodies in Ebola centres were circulating in the communities; Ebola was understood as a death sentence which led to avoiding the health centres, hiding the sick and burying the dead relatives in traditional burial rituals – which triggered more infections. Understanding rumours required a rumour gathering system. The scarcity of information in the organisation of what communities fear, know and wish to know was a major challenge; thus, IFRC initiated a real time emergency knowledge/information management system of socio-anthropological data and rumour management through rapid phone-based surveys building on the network of volunteers. From a governance perspective, IFRC changed their communication approach to be more inclusive and gathered regular feedback from the people and communities they worked with; this led to better relationships and, as a result, improved access to and a better understanding of the communities.

Social science perspective

The social science perspective reflected on the common concepts of community engagement, participative communication and the biomedical narrative in outbreak response and advocated for a paradigm shift. Communities are smart, as their behavioural patterns and norms are survival mechanisms which make sense in their contexts. Discrediting behaviour as irrational does not value the practical intelligence communities have. Rumours, for example, should not merely be understood as signs of misconception and misunderstanding, but considered as important indicators that could guide outbreak detection. Fighting and "confronting" rumours with the "truth" does not work, because representatives of an official biomedical rationale and communities have different concepts of risks. While international health workers stressed, for example, the importance of hygiene and recommended to wash hands regularly and avoid contact with sick or dead people, these hygiene risks were not what the communities perceived as risks. From their perspective the major risk was to be buried in a non-traditional way. In order to mitigate the risk of a non-traditional burial, communities resisted the advice and even reacted at times with violence as their worries and information demands were not met. For this reason, dialogues with communities can be unsuccessful as international health professionals represent a biomedical narrative and consider Ebola as an epidemiological problem, whereas communities see Ebola as a social problem and may have different priorities. The community engagement approach of international stakeholders was also critically reflected. Engaging communities is often practised by working with key community people. However, this engagement approach is prone to replicating the official local distribution of power and authority (e.g. community chiefs) and neglect those community members who can play relevant roles but are less established in the international community engagement approach such as faith healers, midwives and "queen mums". To this end, risk communication should include broader leadership roles of communities and be rather empowering than engaging.

Institutional reflections on outbreak management

The German ***Robert Koch Institute*** (RKI) continued the critical reflection on the two aspects of the Ebola outbreaks: Ebola as epidemiological event and as a social event. From an epidemiological point of view, the RKI did the required preparedness for outbreak response and assessed the risk of Ebola in Germany as low. However, the

public and media interest showed a dynamic that was not in relation to the epidemiological public health risk. While the RKI was well prepared for Ebola in terms of an infectious disease, the dynamic of public awareness was somewhat surprising. Having two outbreaks dynamics – the epidemiological and the social dynamic – is not unique to Ebola, but is a common phenomenon. The outbreak of Shiga toxin-producing *E. coli* (STEC) that can cause Haemolytic Uraemic Syndrome (HUS) in Germany in 2011 provided key insights into national risk and outbreak communications. This large outbreak showed a different clinic pattern and even caused 54 deaths and almost 845 cases of HUS.[17] A key challenge was to determine the source of the food contamination and communication of this uncertainty was particularly difficult and of high impact. The public health authority found itself managing two challenges: the epidemiological outbreak and the social dynamic of a strong public interest. The public health interest and media attention seemed to have followed different, non-medical triggers and it was thus difficult for scientists in charge of managing the outbreak investigations to integrate this dynamic into an overall management. Furthermore, certain actors from food industry suffered economic repercussions after the announcement of false information that a vegetable of a particular country was the source of this contamination. The STEC experience showed that a better understanding of the dynamic of public interest would improve the epidemiological preparedness planning. Risk communication strategies should therefore include the social perspective into their assessments and offer a more holistic view of the outbreak dynamics. These broader assessments require the collaboration of different disciplines and technical areas – and a governance approach that reinforces and encourages multidisciplinary and multisectoral collaboration in regards to more comprehensive information gathering, assessing and sharing.

Point of entry: international airports

International airports are interfaces linking the private sector of nationally and internationally regulated aviation industry to public health, which is also regulated both at national and international level. To this end, airports are epitomes of multisectoral collaboration with the operational rationale of minimising negative impacts both on economies and health while maintaining business continuity. Information management and communication play a key role and are organised in Standard Operating Procedures (SOPs) in compliance with national and international regulations. As a private sector

entity the airport is well aware of the influence of the media and aims to maintain a good relationship with journalists and other public and political groups. The key factor to success is to maintain relationships that are, at a technical level, formalised in SOPs and, at governance level, in personal connections.

Recommendations for the development of risk communication strategies include to start risk communication early, work with multiple stakeholders, initiate and foster collaboration by routine information sharing and communication. Creating the governance that supports this approach is a core management task in teams and organisations dealing with risk communication.

Discussion

The discussions at the conference evolved around four key areas of improvement for risk communication:

- Understanding communication as a multidimensional process in risk communication and enhancing listening approaches and regular feedback mechanisms to allow communities to guide and inform timely changes in risk communication strategies

While this understanding of communication is quite established in theory, practice and, more importantly, organisational governance approaches were slow in adopting this broader, interactive approach to an extent that was more than a lip service. The Ebola outbreak provided a steep learning curve for organisations with the outcome that risk communication is now incorporating community engagement and active listening in their organisation strategies at WHO, IFRC, UNICEF and others.

- Broadening the biomedical paradigm and integrate social science intelligence into epidemiological risk assessments

Different thought cultures, scientific methods and departments in organisations require a strong, respectful and unifying governance approach to enable this collaboration. More importantly, community or lay risk assessment can challenge biomedical orthodoxies; this requires the new role of risk communication as a mediating position, offering explanations to all parties (scientists, lay people, etc.) of the different concepts of risks and moderating and promoting an approach that acknowledges the differences.

- Strengthening multisectoral collaboration and working with local organisations

The collaboration between and among professionals from different sectors and with local organisations is key to prevent and prepare, detect early and respond swiftly to

public health events, but the collaboration can be challenging. This relationship building require times, patience, competence, confidence and trust. All attributes cannot be created during times of urgencies, but need ahead planning and a risk communication governance approach that promotes and reinforces this relationship building as routine practice.

- Spearheading changes in own organisations for better risk communication governance and build capacities and behaviour change in own staff and health professionals

Risk communication is not merely a technical capacity, but a governance approach that enables broader practice and improvements of technical areas. In order to accommodate this new paradigm of risk communication, organisations need to identify and promote changes to enable this risk governance approach. Risk communication is primarily about changing own, organisational behaviour. These changes will then impact the behaviour of others. To integrate this risk communication approach into the governance of organisations and national strategies is the challenge that countries and organisations will have to undertake.

Recommendations

While these improvement areas provide important information, the key element in the discussion was how these improvements can be reflected in risk communication strategies at national levels: what do health authorities need to consider in the development of risk communication strategies? Key recommendations for the development of risk communication strategies were given in four areas: Governance as well as the three strategic axes of information, communication and coordination:

Governance & Organisation

1. Build networks with stakeholders within the health sector and from other sectors, media, civil society and start sharing information and communicate regularly.
2. Aim for a shared community engagement approach that can be activated in case of outbreaks.
3. Start installing a cultural change within the organisation by building the competence, capacity and skills in health authorities and professionals to understand and practice risk communication.

Information

4. Integrate social science (sociology, anthropology, psychology, etc.) and other sources into risk assessment to broaden the biomedical narrative.
5. Listen to communities to gather intelligence and regular feedback on risk communication approaches and biomedical services.

Communication

6. Communication is not just the conveyance of information. Build relationship and engage with communities and media.
7. Media should be seen as a partner supporting risk communication to bridge the gap between the perception of the public and the scientific assessment of risks
8. Have a proactive, transparent and participatory communication approach.

Coordination

9. Have clear and transparent coordination and collaboration mechanisms that enable learning.
10. Integrate risk communication into public health disciplines to improve risk assessment, planning and preparedness for public health risks.
11. Have a national risk communication strategy and operational plan including all stakeholders, for instance local organizations working at community level; share nationally and internationally and exercise this approach.

Conclusion

The conference provided a platform for exchanges of experiences and expertise and the discussion highlighted the major themes of risk communication: Risk communicaiton should be proactive, participatory, multisectoral, facilitating the connection between sectors and strengthening collaboration. National strategies on risk communication should conceptualise risk communication on a governance and organisational level and along its three strategic axes of information, communication and coordination. Relevant areas for improvement were identified, such as to understand communication as a multidimensional process in the risk communication, broaden the biomedical paradigm and integrate social science intelligence into epidemiological risk assessments, strengthen multisectoral collaboration to ensure relevant advice, and spearhead changes in own organisations for better risk communication governance and develop capacities and behavioural change in own staff and health professionals.

The results of this conference inform the development of national risk communication strategies in Morocco and Tunisia.

References

1 BWC 2008. Meeting of the States Parties to the Convention on the Prohibition of the Development PaSoBBaTWaoTD. Report of the meeting of states parties. Geneva: 2008 Contract No.: BWC/MSP/2008/5.

2 WHO. International Health Regulations (IHR 2005). Geneva: World Health Organization, 2008. http://apps.who.int/iris/bitstream/10665/43883/1/9789241580410_eng.pdf (accessed 31 January 2016)

3 Andrus JK, Aguilera X, Oliva O, Aldighieri S. Global health security and the International Health Regulations. BMC public health. 2010;10 Suppl 1:S2.

4 WHO. International Health Regulations (IHR 2005): IHR Core Capacity Monitoring Framework;http://apps.who.int/iris/bitstream/10665/84933/1/WHO_HSE_GCR_2013.2_eng.pdf (accessed 31 January 2016), April 2013, p. 13.

5 WHO. Outbreak communication planning guide. 2008 http://www.who.int/ihr/elibrary/WHOOutbreakCommsPlanngGuide.pdf (accessed 31 January 2016)

6 CDC. Crisis emergency risk communication manual, Edition 2014, http://emergency.cdc.gov/cerc/resources/pdf/cerc_2014edition.pdf (accessed 31 January 2016)

7 Bol GF. Risk communication in times of crisis: Pitfalls and challenges in ensuring preparedness instead of hysterics. EMBO Rep. 2016;17(1):1-9.

8 Glik DC. Risk communication for public health emergencies. Annual review of public health. 2007;28:33-54.

9 Dickmann P, Keith K, Comer C, Abraham G, Gopal R, Marui E. Report of the International Conference on Risk Communication Strategies for BSL-4 laboratories, Tokyo, October 3-5, 2007. Biosecur Bioterror. 2009;7(2):227-33.

10 Rubin GJ, Potts HW, Michie S. The impact of communications about swine flu (influenza A H1N1v) on public responses to the outbreak: results from 36 national telephone surveys in the UK. Health Technol Assess. 2010;14(34):183-266.

11 Dickmann P, Apfel F, Biedenkopf N, Eickmann M, Becker S. Marburg biosafety and biosecurity scale (MBBS): a framework for risk assessment and risk communication. Health Secur. 2015;13(2):88-95.

12 Rubin GJ, Page L, Morgan O, Pinder RJ, Riley P, Hatch S, et al. Public information needs after the poisoning of Alexander Litvinenko with polonium-210 in London: cross sectional telephone survey and qualitative analysis. BMJ. 2007;335(7630):1143.

13 Rubin GJ, Amlot R, Page L. The London polonium incident: lessons in risk communications. Health Phys. 2011;101(5):545-50.

14 Abraham T. Lessons from the pandemic: the need for new tools for risk and outbreak communication. Emerg Health Threats J. 2011;4:7160.

15 WHO. Joint External Evaluation Tool (JEE): International Health Regualtions, Geneva: WHO/HSE/GCR/2016.2

http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf

(accessed 29 June 2016)

16 WHO. Technical consultation on monitoring and evaluation of functional core capacity for implementing the International Health Regulations (2005). Geneva: WHO/HSE; WHO/HSE/GCR/2015.14.

http://apps.who.int/iris/bitstream/10665/199527/1/WHO_HSE_GCR_2015.14_eng.pdf?ua=1

(accessed 31 January 2016)

17 Frank C., Werber D, Cramer JP, Askar M, Faber M., an der Heiden M, (et al.) Epidemic Profile of Shiga-Toxin‑Producing *Escherichia coli* O104:H4 Outbreak in Germany, NEJM 2011; 365(19): 1771-80.

IV. Assessment score for public health security

1. THE MARBURG BIOSAFETY AND BIOSECURITY SCALE (MBBS): A framework for risk assessment and risk communication[22]

Abstract

Current risk assessment and risk communication of biosafety and biosecurity lacks a convenient metric and conceptual framework. The absence of such a systematic tool, the authors argue, makes communication more difficult and can lead to ambiguous public perception of and response to biosafety incidents and biosecurity threats. A new seven category scoring scale for the handling of human and animal pathogens is proposed that could help clarify risk categories, facilitate coordination and communication and improve public understanding of risk related to biosafety and biosecurity.

Keywords: Biosafety, Biosecurity, BSL4, Biocontainment, Risk assessment, Risk communication

Introduction

International prevention and control of infectious diseases epidemics and pandemics such as Influenza and in particular outbreaks of emerging and re-emerging highly infectious pathogens such as SARS coronavirus, Middle East Respiratory Syndrome (MERS)-coronavirus and Ebola virus require a variety of health system capacities including laboratories that can diagnose and conduct research on such pathogenic agents.[1, 2] All Member States of the World Health Organization (WHO) have recognised the importance of this capacity building in their adoption of the International Health Regulations (IHR 2005) which legally obliges all countries to build and maintain the capacity to prevent and respond to public health emergencies.[2] There is a general agreement that scientific investigation of human and animal pathogens is necessary for preparedness of and response to outbreaks. Thus, the implementation of biosafety and

[22] Petra Dickmann, Franklin Apfel, Nadine Biedenkopf, Markus Eickmann and Stephan Becker (2015): Marburg Biosafety and Biosecurity Scale (MBBS) – a framework for risk assessment and risk communication, Health Security 03/2015, 2(13): 88-95.

biosecurity measures is of high priority to ensure safe and secure handling of biomaterials.

Concepts of biosafety and biosecurity

Biosafety refers to principles, technologies, practices and measures implemented to prevent the accidental release of, or unintentional exposure to, infectious or toxic biological agents. *Biosecurity* refers to the protection, control and accountability measures implemented to prevent the loss, theft, misuse, diversion or intentional release of infectious or toxic biological agents and related resources as well as unauthorized access to, retention or transfer of such material.[3]

Biocontainment

To ensure the safety of laboratory personnel and the environment, work on pathogens in laboratory settings is currently classified in biosafety levels 1-4 (BSL1-4).[4] The biosafety levels are designated in ascending order, by degree of protection needed for personnel, the environment, and the community.

This classification draws on the concept of *biocontainment* that is the difference between a pathogenic interior and a less pathogenic exterior such as work/personnel or laboratory/environment and a stabile barrier between them. [5] The physical containment of infectious pathogens or toxins is required to prevent accidental infection of workers or release of pathogens into the environment during scientific research or diagnostics.

Biosafety and biosecurity threats

Laboratories of high and highest biosafety level, BSL3 and 4, handle human and animal pathogenic agents, against which no treatment or vaccines are available. Those laboratories are necessary to diagnose infectious pathogens, guide infection control measures and conduct research into new vaccines and treatment options. Very strict guidelines regulate BSL3 and 4 laboratory operations. The sheer existence of a high security laboratory is perceived as threatening as incidents could cause pathogens to physically escape the laboratory and contaminate the environment and accidents inside the laboratory could occur that lead to laboratory-acquired infections.[6-9] In the aftermath of the anthrax letters, biosecurity fears have also increased. Concerns have been raised about BSL4 laboratories, in particular, as potential source of security threats because their materials and technologies could be used to threaten societies.

Dual use dilemma

Research and development in the field of biomedical sciences pose a dual use dilemma. While scientific discoveries can be used in beneficial ways to cure diseases and improve health, they can also be used for malicious purposes, e.g. as biological weapons. Dual use as a conceptual term originates from the cold war where it was applied to concerns related to nuclear material and its weaponisation. Biomedical sciences in the post genomic era bring a new dimension to the dual use dilemma: their dual use potential is not only material-based (e.g. possession of pathogens), but, more importantly, information-based (possession of sequence information).[10] The relevant dual aspects are not only physical possession of pathogens but also knowledge and information about how to modify or manipulate the original structure (e.g. sequences of amino acids, mutations, etc.). These dual use concerns have recently been broadly discussed when researchers successfully introduced mutations to an avian influenza virus that enhanced its transmissibility (gain-of-functions experiments).[11,12]

Risk assessment and risk communication

Biosafety, biosecurity and dual use concepts are complex, lack standardisation, and are often understood differently by scientific and security experts, policy-makers and the public. Current risk assessment and communication of biosafety and biosecurity add ambiguity as they lack explicit metrics. To address this challenge we have developed a new scale to help frame risk assessment and facilitate risk communication related to the classification of biosafety incidents and biosecurity levels.

Concept: Marburg Biosafety and Biosecurity Scale (MBBS)

Drawing on the concept of scaling nuclear events using the International Nuclear Event Scale (INES) an explicit metric was developed to assess biosafety incidents and biosecurity levels using a scale from 0 to 7.

For biosafety, we evaluate the impact of laboratory-originated incidents on personnel, integrity of containment (in this context: biocontainment) and the environment. In order to avoid confusion with the BSL classification and to emphasise what we are measuring, we use a biosafety incident scale to classify what kind of incidents could occur in laboratories that handle human and animal pathogens and how severe they are in terms of impact on personnel, containment and environment. Biosafety incidents 0-

3 describe incidents that could, however unlikely, happen within routine laboratory operations; incident levels 4-7 describe accidents or attacks from external acteurs. From incident level 4 on, biosafety and biosecurity scale merge.

For biosecurity, we use levels to classify situations. Our starting point is the distinction between physical/material-base and intangible/information-based threats and we then further reflect issues related to the impacts on individuals, integrity of containment (in this context: control and effectiveness of response mechanisms) and the public. In contrast to the biosafety incident scale, the biosecurity levels 0-3 describe situations and not incidents. Only from biosecurity levels 4 and higher does the scale describe incidents. Botulinum toxin, for instance, is a biosecurity relevant pathogen that is currently in use for medical and cosmetic purposes. This is a biosecurity level 0. If botulinum toxin would be used to intentionally harm a person (biosecurity level 4) or in synchronised attacks in one country (biosecurity 6) or several countries (biosecurity level 7) the biosecurity level would increase.

The first four scores (MBBS 0-3) of biosafety and biosecurity relevant incidents and situations develop (and would be reported) independently while from MBBS 4 on biosafety and biosecurity aspects move closer together, are less discrete and have a similar common final path (locally contained, regional, national and international impact). Literally, the biosafety and biosecurity scale forms a Y-shape where one arm of the Y is the biosafety branch and the other arm the biosecurity arm, both leading into a common final path.

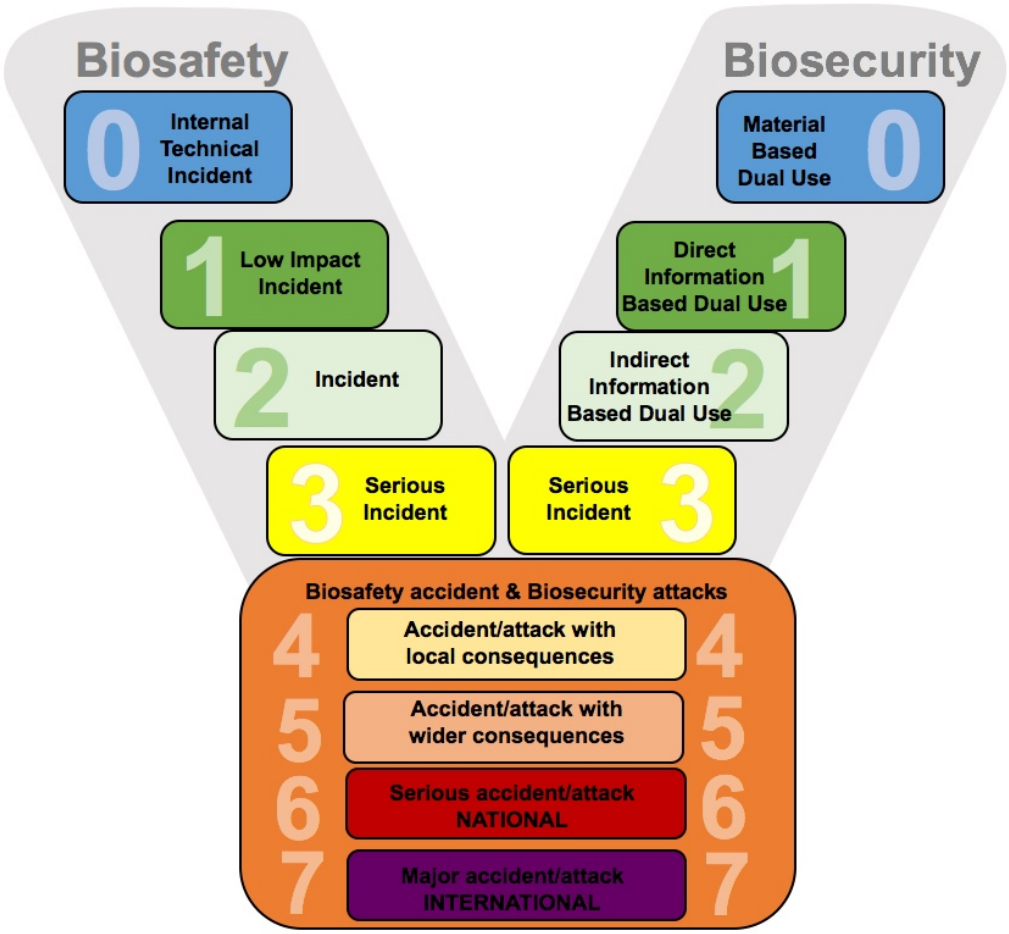

Figure 1: Y-shape of biosafety and biosecurity scale

***Marburg Biosafety and Biosecurity Scale* – Biosafety branch**

The biosafety branch refers to work on human and animal pathogens in high containment laboratories (BSL3-4) and provides a metric for evaluating incidents in regards to the impact they have on personnel, the integrity of the containment and the environment.

Biosafety incident O classifies an incident of no or minor impact on personnel and integrity of containment and no impact on the environment. A hole in one of the three gloves e.g. due to a material defect without contamination would be an example. In the laboratory such events are described as technical incidents and are recorded in the record book of each laboratory but do not require any notification to regulatory authorities. Although this situation does not require notification to authorities, all personnel are informed about such technical incidents. Reporting of such incidents, however minor, is a very important for the safe operation of high containment laboratories. From a safety control system perspective, such reporting should never

have negative professional consequences and, in fact, reporting should be encouraged to improve the overall adoption of safer working practises.

Incident level 1 classifies a situation where there is a minor impact on the integrity of biocontainment, no or minor impact on personnel and no impact on the environment. A torn protection suit without infectious risks would be an example. This kind of low impact incidents requires notification to the organisational authority of the laboratory and information for all staff is provided.

Incident level 2 classifies a situation where there is an impact on personnel and integrity of the biocontainment, but no impact on the environment. A needle-stick injury with infectious risk would be one example. Notifications of laboratory and health authorities are required for activation of response protocols and appropriate treatment measures for the injured are activated. Information for all personnel is provided.

Incident level 3 classifies a serious incident that affects personnel, the integrity of the biocontainment **and** the environment. This could be the case when infected staff has not been quarantined and transmission of disease to people inside and outside the laboratory cannot be excluded, but are not reported yet.

The leakage of agricultural relevant pathogens e.g., foot-and-mouth-disease virus from the laboratory into the environment because of a damaged sewage system with limited infections would be another incident level 3 situation. Response measures include notification of laboratory and public health authorities, as well as national authorities to activate containment measures and contact tracing. Information for personnel, local communities and general public should be provided.

Incident level 4 classifies situations that are the result of physical damage to the containment. A fire due to a defective electrical device that damages the integrity of the biocontainment and leads to a release of pathogens (if they are not inactivated by the heat of the fire) would be one example for this level of a local accident. Level 4 is defined by situations where the environment may be contaminated but personnel are not exposed, e.g. a fire happening during the night. In such circumstances the emergency response team would focus on measures protecting the local area. Organisational, health and security authorities would work according to their emergency protocols. Information for personnel, local community and the public should be provided.

Incident level 5 classifies situations in which an accident has wider consequences and personnel and the public was exposed. Exposed persons are in quarantine, contact tracing would be implemented. Similar emergency response measures would be taken like in level 4.

Incident level 6 is an escalation of level 5 where disease cases in consequence of exposure are reported indicating a sustained chain of transmission. Infections, however, are limited to one country.

Incident level 7 is the widest escalation with cases are detected in various countries. In this case national and international emergency response measures should be placed.

Marburg Biosafety and Biosecurity Scale (MBBS) – Biosafety branch

Biosafety	Descripti0n	Impact on personnel	Impact on integrity of containment	Impact on the environment	Examples	Consequences
0	*Internal technical incident* No notification required	No or minor impact 0	No or minor impact 0	No 0	A hole in one of the three gloves	Adaption of organisation; Information of all staff
1	*Low impact incident* Notification required	Minor impact 0	Minor impact I	No 0	A torn protection suit *without* infectious risk	Notification of laboratory authority and occupational health Information of all staff

2	*Incident* Notification required	Suspected case (Limited loss of layered security measures) I	Minor impact I	No 0	Needle stick injury *with* infectious risk	Notification of laboratory, occupational and health authorities Quarantine Information of all staff
3	*Serious incident* Notification required	Contamination and/or health threats Loss of layered security measures I	Minor impact I	Possible infection of contact persons I	Contagious staff *without* Quarantine (Probable case) Leakage of sewage water or unsafe waste (e.g. Pirbright)	Contact tracing Containment efforts Notification protocol Information of staff and public

4	*Accident with local consequences*	Staff not exposed (e.g. during the night)	Damage to laboratory and integrity of containment	Release of pathogens to environment Potential exposure of the public	Sudden excess pressure (explosion) Release of pathogens	Police and fire fighters close off the local environment Emergency protocol Information of staff and public
5	*Accident with wider consequences*	Contamination of staff	Damage to laboratory and integrity of containment	Release of pathogens to environment Potential exposure of the public	Sudden excess pressure (explosion) Release of pathogens	Police and fire fighters close off the local environment Emergency protocol Information of staff and public
6	*Serious Accident*	Contamination of staff	Serious damage to laboratory and integrity of containment	Release of pathogens to environment	Sudden excess pressure (explosion)	National emergency response protocol Information of staff and public

				Cases in the public (one country)	Release of pathogens	
7	*Major Accident*	Contamination of staff	Severe damage to laboratory and integrity of containment	Release of pathogens to environment Cases in several countries	Sudden excess pressure (explosion) Release of pathogens	International emergency response protocol Information of staff and public

Table 1: Marburg Biosafety and Biosecurity Scale (MBBS) – Biosafety branch

Marburg Biosafety and Biosecurity Scale (MBBS) – Biosecurity branch

The biosecurity branch of the Marburg Biosafety and Biosecurity Scale (MMBS) includes level 0 to 7 where the first four biosecurity levels MBBS 0-3 describe situations of laboratory development or manipulations whereas biosecurity levels MBBS 4 – 7 classifies incidents with wider implications. The biosecurity scale, however, does not include the wide-ranging long-term social and political amplification and ripple effects biosecurity incidents could have on society.

Biosecurity in this understanding refers to any activity, material, knowledge and information that could be used for malicious purposes to pose threats, commit crime or terror attacks.

As an initial distinction we discriminate between tangible, physical dimensions or intangible, information-based dimensions of biological threats. We evaluate biological threats against its impact on individuals, on the integrity of containment (this includes the ability to respond to infectious diseases and contain the pathogen) and on the public.

Biosecurity level 0 classifies the situation of the tangible, factual material existence of pathogens or toxins in the local community and/or environment, e.g. ricin growing on bushes, anthrax can be found in the soil, *c. botulinum* in medical and cosmetic use and avian influenza occurring naturally.

Biosecurity level 1 classifies the situation of intangible dual use where information can be used to modify pathogens based on direct, information-based application of common laboratory practice. As a result, pathogens can become more dangerous to humans. Examples are gain-of-function experiments that modify transmissibility or mortality in a laboratory setting.

Biosecurity level 2 describes an escalation of level 1 in which information-based, scientific achievements are used in an interdisciplinary approach to modify characteristics. One example would be the anthrax letters: the anthrax spores were coated in a particular manner to avoid clumping which presents a common problem in the dispersion of fine powder; this technique is used in a different science (engineering, physics) and the lateral application poses a different and new threat level.

Biosecurity level 3 classifies the situation of a material-based theft of pathogenic agents with minor impact on individuals and the integrity of the containment and potential impact on the public. In contrast to biosafety level 3 where pathogenic agents could be released incidentally, this biosecurity level 3 has a criminal or terrorist purpose.

Biosecurity level 4 classifies an attack with local consequences, such as an attack on an individual with a pathogenic agent. Impact on individuals would be minor to major, minor impact on the public and treatment and/or prophylaxis are available.

Biosecurity level 5 classifies the situation of intentional release of a pathogen to a group of public with major impact on individuals and the public while prophylaxis and/or treatment is available. Difference to level 4 is the occurrence of several cases in the countries, probably as a synchronised attack.

Biosecurity level 6 classifies the situation of intentional release of a pathogen to a group of public where treatment and/or prophylaxis is unavailable and several cases occur nationally. Difference to level 5 is that the epidemiological containment measures are limited (no prophylaxis or causal treatment).

Biosecurity level 7 classifies the situation of an intentional release of a pathogen where cases occur in different countries and prophylaxis and/or treatment is not available.

Marburg Biosafety and Biosecurity Scale (MBBS) – Biosecurity branch

Biosecurity	**Tangible/Physical**	**Intangible/Information**	**Impact on individuals**	**Impact on integrity of containment**	**Impact on the public**	**Examples**	**Possible Response strategies** **Consequences**
0	*Dual use dilemma* Material base		No or minor impact 0	No or minor impact 0	No 0	Pathogens	Education and training Risk communication Policy Awareness
1		*Dual use dilemma* Information base Direct	No or minor impact 0	Minor impact I	No 0	Gain-of-function research and publication	Education and training Risk communication Policy Awareness
2		*Dual use dilemma* Information base Indirect	No or minor impact	Minor impact	No	Lateral application of gain-of-function	Education and training

			I	I	0	research and publication	Risk communication Policy Awareness
3	*Serious incident* Notification required		Minor impact I	Minor impact I	Potential impact I	Theft of pathogenic material from a BSL3 or 4 lab	Security and intelligence investigations Risk communication
4	*Attack with local consequences*		Minor to major impact	Prophylaxis and/or treatment *available*	Minor	Intentional release of pathogens to attack individuals (e.g. Markov Ricin attack)	Security and intelligence investigations Risk and crisis communication

5	*Attack with wider consequences*		Major	Prophylaxis and/or treatment *available*	Major	Intentional release of pathogens Several cases in one country	Security and intelligence investigations Emergency protocol Information of staff and public
6	*Serious Attack*		Major	Prophylaxis and/or treatment *unavailable*	Major	Intentional release of pathogens Several cases in one country	National emergency response protocol Information of staff and public
7	*Major Attack*		Major	Prophylaxis and/or treatment *unavailable*	Major	Intentional release of pathogens Cases in several countries	International emergency response protocol Information of staff and public

Table 2: Marburg Biosafety and Biosecurity Scale (MBBS) – Biosecurity branch

Discussion

This proposed scale provides a unique framework for a rational and transparent classification of biosafety and biosecurity concern both prospectively and retrospectively to contribute to the assessment and communication of biological risks. Until now, there has been no rating or scaling of biological risks. However, in the field of biosafety, emergency protocols are in place and are exercised in different settings such as in lab exercises or national exercises that form part of routine quality control procedures. Biosecurity is more vague and there are no or less established routines to respond to these threats and test and evaluate the effectiveness of response measures.

Scope

The biosafety incident scale can contribute to a clearer understanding of the nature of incidents in the laboratory (incident level 0-3) and accidents or attacks on laboratories (incident level 4-7) while the biosecurity level provides an overview of situations (biosecurity level 0-3) and incidents (biosecurity level 4-7). Both scales merge from incident/level 4 on where 'accidents' at/to laboratories are the results of intentional malicious purposes, such as an explosion in/at a BSL4 laboratory.

Assessment

The MBBS scale could be used to better understand incidents and consequences and re-think strategic response measures. Having an explicit framework in place that illustrates where in the scale the situation actually is, how it could develop and what might be necessary, is important strategic information that can inform response strategies well ahead of escalating situations. Response mechanisms to biosecurity threats are not unified and in place. For this purpose, we included a column on possible response strategies and consequences. This could be used by relevant institutions and groups to reflect and structure their response.

Re-assessment

Working through scenarios the scale, for example, could show that the former, often intuitive risk assessment assuming that BSL4 labs are more dangerous than BSL3 laboratories could be misleading. BSL4 work is highly regulated and certain threats such as explosions cannot happen – as all explosive materials are prohibited inside BSL4 facilities per se. BSL3 labs are less regulated and wider distributed; having higher levels on the biosafety scale might lead to a re-think among regulators and policy makers.

Quality control

The notification and reporting that are required on the different levels could also be used to evaluate quality in laboratories.

Improved communication

A major aspect of this scale is to allow a clearer and more consistent communication. Having the same explicit rationale in place facilitate coordination with institutions and communication with colleagues and the public.

Bioseverity scale

In order to better understand the health implication of biosafety and biosecurity 4-7 and the severity of the epidemiological situation a third assessment and communication rationale would be necessary to classify clinical outbreak scenarios and guide public health response. This "bioseverity scale" is currently being developed to assess the clinical and epidemiological situation for public health responses.

Limitations

The proposed MBBS scale is a conceptual evaluation framework and metric and its applicability and benefit need to be demonstrated in further discussions and use. However, the Marburg Biosafety and Biosecurity scale does not include a way of measuring the social and political factors that shape and have implications for both the identification and responses to incidents, accidents and attacks. In its current form it is limited to developing a standardized measuring and communicating tool that could improve understanding and clarity of risk assessment and communication related to laboratory safety and security.

Intelligence

The key question for security intelligence is how easily or likely a biosecurity level 0-3 could develop into biosecurity 4-7, or how likely a biosafety incident 4-7 is. However, the purpose of this scale at this stage is to provide an explicit rationale for assessment and communication; it does not provide an intelligence tool to assess how likely or feasible situations may develop.

Conclusion

Drawing on similar scales to rate and evaluate natural threats and nuclear events, this biosafety and biosecurity scale provides an explicit metric to rate biosafety and biosecurity to improve

risk assessment and risk communication. It could also serve to improve quality assessment of laboratory work, inform policy and political decision-makers and help conceptualize appropriate response measures.

References

1. Gulland A. Ebola outbreak claims more than 60 lives. BMJ 2014; 348: g2473.
2. World Health Organization. International Health Regulations 2005, 2nd Edition World Health Organization, Geneva 2005.
3. Meeting of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, Report of the meeting of states parties. Geneva 2008 Contract No.: BWC/MSP/2008/5.
4. Centres for Disease Control. Principles of Biosafety. In: CDC, editor. Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition. 2009.
5. Patterson A, Fennington K, Bayha R, Wax D, Hirschberg R, Boyd N, et al. Biocontainment Laboratory Risk Assessment: Perspectives and Considerations. Pathogens and disease. 2014.
6. Dickmann P, Keith K, Comer C, Abraham G, Gopal R, Marui E. Report of the International Conference on Risk Communication Strategies for BSL-4 laboratories, Tokyo, October 3-5, 2007. Biosecurity and bioterrorism 2009; 7(2): 227-33.
7. Foot and mouth: mystery outbreak at Pirbright. Nature 1970; 228(5270): 403.
8. Gunther S, Feldmann H, Geisbert TW, Hensley LE, Rollin PE, Nichol ST, et al. Management of accidental exposure to Ebola virus in the biosafety level 4 laboratory, Hamburg, Germany. The Journal of infectious diseases 2011; 204 Suppl 3: S785-90.
9. Report of the Investigation into the Cause of the 1978 Birmingham Smallpox Occurrence (22 July 1980). London: Her Majesty's Stationary Office, 1980.
10. Dickmann P. Biosecurity - Biomedizinisches Wissen zwischen Sicherheit und Gefährdung. Bielefeld: Transcript, 2012.
11. Fouchier RA, Herfst S, Osterhaus AD. Public health and biosecurity. Restricted data on influenza H5N1 virus transmission. Science 2012; 335(6069): 662-3.
12. Herfst S, Schrauwen EJ, Linster M, Chutinimitkul S, de Wit E, Munster VJ, et al. Airborne transmission of influenza A/H5N1 virus between ferrets. Science 2012; 336(6088): 1534-41.

2. LOCAL – PEOPLE – MAKE SENSE: BIOSAFETY AND BIOSECURITY: A relative risk-based framework for safer, more secure and sustainable laboratory capacity building[23]

Abstract

Background: Laboratory capacity building is characterized by a paradox between endemicity and resources: Countries with high endemicity of pathogenic agents often have low and intermittent resources (water, electricity) and capacities (laboratories, trained staff, adequate regulations). Meanwhile, countries with low endemicity of pathogenic agents often have high containment facilities with costly infrastructure and maintenance governed by regulations. The common practice of exporting high biocontainment facilities and standards is not sustainable and concerns about biosafety and biosecurity require careful consideration.

Methods: A group at Chatham House developed a draft conceptual framework for safer, more secure and sustainable laboratory capacity building.

Results: The draft generic framework is guided by the phrase 'LOCAL – PEOPLE – MAKE SENSE' that represents three major principles: capacity building according to local needs (local) with an emphasis on relationship and trust-building (people) and continuous outcome and impact measurement (make sense).

Conclusions: This draft generic framework can serve as a blueprint for international policy decision-making on improving biosafety and biosecurity in laboratory capacity building, but requires more testing and detailing development.

Keywords: Biosafety, Biosecurity, Laboratory capacity building, Biorisk, International Health Regulations, Emerging infectious diseases

INTRODUCTION

Background

International prevention and control of infectious diseases requires a variety of health (human and animal) system capacities including laboratory capacity for surveillance and diagnostics worldwide.[1-3] This capacity building is recognised and enforced by the revised International

[23] Petra Dickmann, Heather Sheeley and Nigel Lightfoot (2015) Biosafety and biosecurity: a relative risk-based framework for safer, more secure, and sustainable laboratory capacity building. Front. Public Health 3:241. doi: 10.3389/fpubh.2015.00241

Health Regulations (IHR 2005) of the World Health Organization (WHO).[4-6] Building laboratory capacity worldwide is, however, an activity with intrinsic complexities and paradoxes: countries with high endemicity of disease often have low resources (water, electricity) and capacities (laboratories, trained staff, adequate regulations) to survey and diagnose the diseases caused by these agents; whereas countries with low endemicity of high pathogenic agents often have high containment facilities with costly infrastructure and maintenance.

With increasing laboratory capacity worldwide the global health security agenda considers biosafety and biosecurity topics as relevant.[7-9] In the international convention, *Biosafety* refers to "principles, technologies, practices and measures implemented to prevent the accidental release of, or unintentional exposure to pathogenic agents."[10] *Biosecurity* refers to the "protection, control and accountability measures implemented to prevent the loss, theft, misuse, diversion or intentional release of pathogenic agents and related resources as well as unauthorized access to, retention or transfer of such material."[10] It is necessary to get the balance of concerns over proliferation and the need to diagnosis and undertake surveillance.

Biomaterials have to be handled safely and securely in all settings: work on harmful and infectious biological materials inside laboratories needs to be contained and separated from a not-contaminated environment (biocontainment). To ensure the safety of laboratory personnel and the environment, work on pathogens in high-resource laboratory settings is classified in biosafety levels 1-4 (BSL1-4).[11] This classification draws on the concept of step-wise biocontainment that aims at keeping the pathogen confined to a designated space. Biocontainment, however, allows for a relative risk based, differential approach by focussing on the difference – the barrier – between a pathogenic interior and a less pathogenic exterior. The physical containment of pathogens protects the workers or the unintended release of pathogens that could lead to laboratories being the source of outbreaks. In high-resource settings regulations for safe operations in animal and human health laboratories exist.[12-16] However, despite its containment standards laboratory accidents[17], unintentional exposure[18-20] and unintentional release[21,22] occur and maintenance of these containment standard are strongly recommended.[23, 24]

Additionally, security concerns exist about the proliferation of high-containment laboratories and the illegal acquisition or intentional release of high consequence pathogenic agents. Systems designed to prevent the misuse of potentially hazardous biological material are

generally described as biosecurity systems. Despite its importance, biosecurity concepts and approaches, however, are less well understood, not always adequately reflected, connected and implemented with biosafety systems.[25, 26] Recently, a framework to help evaluate biosafety and biosecurity incidents provide a useful rationale.[27] This framework uses a seven category scale to assess incidents and situation ins regards to their impacts on personnel, integrity of containment and the environment. [27] Using this metric and rating system for risk assessment could improve the common understanding of biosafety and biosecurity risks and facilitate risk communication.

To ensure the safe and secure handling of pathogenic agents the current practice is mainly focussed on exporting the complex costly containment, 'western standard' of laboratory safety into vulnerable areas of the world with high demand for laboratory activity due to emergency outbreak situations or a continuous high prevalence. This practice has not always been effective to date, needed investments have not been fully sustainable, the 'western standard' of biosafety relies on adequate and continuous access to resources and educated personnel.[28-30] Biosecurity concepts and approaches have been very slow to be addressed this at the same rate as the development of biosafety systems.[31]
The Global Health Security Agenda points to a lack of collaboration and integration of health and security approaches and communities and thus calls to end the silo-thinking and encourages an integrated health security approach.[5, 32-34]

There is a need for new and innovative approaches to building laboratory capacity worldwide, and in particular in low-resource settings, and ensure safe and secure handling of biomaterials.

Safe and Secure Biomaterial Project
To this end, a Chatham House project on "Safe and Secure Biomaterials", funded by the UK International Biosecurity Programme, aimed to explore and analyse the practice and regulations of biosafety and biosecurity in low- and high-resource settings and develop a generic framework that could guide international policy decision-making to build laboratory capacity with a focus on low-resource settings.
This project had two phases. In phase 1 (2012) of this research project, stakeholders were convened to discuss the research problem, the project plan of international laboratory capacity building and to provide an overview of the landscape of biosafety and biosecurity regulations and guidelines. In a Chatham House research paper the outcomes of the first phase describes

the need for laboratory capacity building, the discrepancy between endemicity and resources, different standards of biosafety and biosecurity regulations in G7 and seven low- and middle-income countries and the isolated approaches of the health and security communities.[35,36] The research paper suggests a relative risk approach to rethink current regulations and practices for further exploration in the next phase of the project.[37, 38]

Phase 2 of the project (2014) used the conceptual framing of the relative risk approach to discuss and develop a generic framework for a safer, more secure and sustainable laboratory capacity building. In a scoping meeting with international stakeholders the approach and initial framework ideas were discussed and tested to prepare for a broader workshop. This scoping meeting was attended by 17 senior experts from low, middle- and high-income countries, international organisations and research institutions.

The bigger workshop offered a forum for intense collaboration and interaction of different stakeholders from low- and high-resource settings; the bigger workshop was attended by 23 senior experts from biomedical sciences, engineering and policy-making from both fields of biosafety and biosecurity in low-, middle- and high-income countries. In this bottom-up approach the main pillars of the generic framework were created. This workshop also serves to agree on recommendations and promote this framework for adoption into the international discourse of biosafety and biosecurity.

This article describes the generic framework, discusses the potential implication of this approach and summarises the recommendations for a safer, more secure and sustainable laboratory capacity building.

Methods

Key and diverse stakeholders from differing disciplines and backgrounds reflected and determined a generic framework for assessing best solutions for laboratory capacity building (smaller scoping meeting; larger workshop). This was done in a two-step process: in a smaller scoping meeting stakeholders were consulted to generate feedback on initial ideas to challenge conventional thinking and receive consensus regarding the relative-risk approach that would serve as a narrative to develop a generic framework in a broader workshop scenario.

In a second step, the workshop applied a creative, interactive approach to jointly reflect and elaborate on safer, more secure and sustainable solutions for laboratory capacity building. The two-day workshop was based on interactive, interdisciplinary work in small groups of people coming from different professional backgrounds (biomedical, sciences, engineering and policy-making) with experience from both fields of biosafety and biosecurity in low-, middle-

and high-resource settings[24]. The workshop applied a focus group approach and emphasized group work that was structured to trigger dialogue and debate on current practices, stimulate thinking about what changes could lead to safer, more secure and sustainable laboratory capacity-building (particularly in low-income countries), and capture participant insights on the specific components, attributes and principles of such changes. People from a diverse background and experience used analytical tools and templates to analyse the contradictions, contrasts and issues and presented their results in plenary sessions for broader discussion.

Results

Relative-risk approach

The relative-risk approach to safe and secure laboratory capacity building moves away from the use of predetermined standards under which work on particular pathogens should be performed. Such standards were felt to represent a Western and high-resource setting perspective that is far from realities in different parts of the world and neither achievable nor sustainable in low-resource settings. The relative-risk approach focuses on conditions of biosafety and biosecurity that can make work safer, more secure and sustainable in specific environments. To this end, the approach builds on a *contextual assessment of risks* and considers the system and environments (e.g., information, communication and coordination systems) in which laboratory capacity is being built. This differential approach reflects and relates 'inside' of the laboratory with 'outside' the laboratory and considers the permeability of the barrier separating them. This approach focuses on the barrier that separates the inside from the outside and provides a structured assessment of the relative risks. Rather than defining the endpoint as adherence to Western standards, it focuses on agreed outcomes (e.g. maintaining the biocontainment barrier) and develops contextually appropriate, relevant parameters for biosafety and biosecurity.

Tools and templates used during the workshop incorporated this structure to help participants elicits the contextual parameters. The matrix templates were designed to reflect three dimensions:

- Inside: people
- Barrier: integrity of containment systems

[24] Participants from low, mid- and high income countries were chosen based on their experience in biosafety and biosecurity. The workshop was held under the Chatham House Rule; thus we are not permitted to disclose names.

- Outside: environment, e.g. structures and services

For each dimension (i.e. people, integrity of containment, structures and services), groups identified key influencing factors and described how these could support innovative and sustainable solutions for a safer and more secure handling of biomaterials. To enable this discussion, the matrix required participants to reflect on an ideal situation and compare this to realities in high-resource and low-resource settings.

Biosafety – biosecurity

Biosafety and biosecurity requirements and concerns are often addressed separately and from different stakeholders' perspectives. However, in this workshop participants articulated a shift in the conventional understanding of biosafety and biosecurity: rather than assuming biosafety and biosecurity as different and discrete entities, participants stressed that biosafety and biosecurity aspects are often intertwined and interlinking. Participants agreed that the many aspects and activities of biosafety and biosecurity could be and should be woven together as a tapestry with multiple layers and components, and concluded that the two areas of concern overlap. For instance, safe operations in laboratories require trust between staff members, training and reliable systems. The same aspects are relevant for biosecurity. Instead of stressing the differences, participants reinforced the approach to integrate biosafety and biosecurity in one interdisciplinary discourse.

Objectives of a generic framework: SAFER

The main objectives for a generic framework for safer, more secure and sustainable laboratory capacity building was captured by the SAFER acronym. SAFER stands for

- **S**ustainable: laboratory capacity can be maintained independently over a long term period;
- **A**ffordable: communities do not depend on external aid for core functionality;
- **F**unctional: the laboratory staff are safer than currently, communities are at less risk of the laboratory being the source of the infection and the presence of the surveillance and diagnostic capability keeps the community safer;
- **E**ffective: laboratory capacity building presents the most suitable application for the specific environment; and
- **R**ealistic: laboratory capacity building is an answer to a question that the community actually has.

Generic framework: Local – People – Make sense

The generic framework for sustainable, safer and more secure laboratory capacity has three principles that are summarised in the phrase 'LOCAL – PEOPLE – MAKE SENSE.

The first key principle is the LOCAL principle. This includes

- Involving local people at every stage of capacity building;
- Building on existing infrastructure (assets and needs, on-going developmental plans and activities); and
- Meeting local requirements.
- Sustained locally

The second principle in laboratory capacity building is the PEOPLE principle. It is important to:

- Build relationships;
- Develop trust;
- Develop relevant skills (e.g. laboratory, construction, testing, etc.)
- Engage in two-way communication: gather intelligence insights on perceptions, culture, attitudes and behaviours that then inform communication and compliance;
- Create networks; and
- Advocate for political buy-in.

The third principle reflects the need to monitor, measure and evaluate the process of improving biosafety and biosecurity in support of necessary laboratory procedures. Making sense is an active process that includes:

- Developing metrics to use in measurement and evaluation;
- Identifying relevance of settings and needs;
- Measuring starting points and progress;
- Evaluating effectiveness of the biosafety and biosecurity solution and networks of supporting structures of laboratory capability; and
- Learning and informing developmental planning.

Capacity building action areas: 4M

The key biosafety and biosecurity capacity building areas are summarized in the mnemonic 4M. These are:

- HU**M**AN: referring to training, education and communication activities;
- **M**ETHODS: referring to developing standard operating procedures and guidelines;
- **M**ATERIAL: referring to designing appropriate buildings (engineering and architecture), and security; and
- **M**ONEY: referring to advocating for resource allocations and developing a range of funding models.

Framework to guide decision-making

The framework is a matrix that applies the three key principles (left column) as a y-axis to the four capacity building areas (4M) on an x-axis.

	HU*M*ANS	***M*ETHODS**	***M*ATERIAL**	***M*ONEY**
LOCAL				
PEOPLE				
MAKE SENSE				

Table 1: Local People Make Sense – key criteria for safer, more secure and sustainable capacity-building

The three key principles (Local - People - Make sense) should be applied to each of the capacity building areas. When considering capacity building e.g. in the field of 'HU**M**ANS', training, education and communication activities have to match the 'Local People Make sense' criteria. Training has to include local people, building on existing infrastructures and meet local requirements. Training objectives need to include relationship building, trust development among relevant skill building, etc. Training efforts should be monitored and measured against the SAFER objectives; this requires the development of an appropriate metric in context-sensitive and variable environment, etc.

For capacity building in fields of methods, material and money, the same procedure is envisioned: capacity building activities in the fields of methods, material and money need to comply to the Local – People – Make Sense-principle.

The fields of capacity building activities (Humans, Methods, Materials, Money), as a x-axis, and the Local – People – Make Sense-principle, as a y-axis, presents the guiding frame for the concept and design of activities, the empty fields in the matrix give room to develop solutions in different contexts that make sense in diverse and changing environments.

Discussion

Generic application for local solutions

This framework for sustainable, safer and more secure laboratory capacity is generic and aims to guide decision-making. It does not provide answers, but helps to develop local, context-sensitive solutions. The application of this framework is seen as an iterative process. When facing decisions on if and how to improve laboratory capacity, the framework can help decision makers, scientists, architects and other stakeholders to agree on and achieve SAFER outcomes.

Framework for planning, monitoring and evaluation

This matrix serves as a core part of the conceptual framework that helps guide the i) planning, ii) monitoring and iii) evaluation of alternative approaches to laboratory capacity building worldwide. Although this framework is still in the drafting phase, participants felt that it indicates the right approach and provides planners, public and veterinary health scientists, policy-makers, engineers, architects and other professionals with a useful tool.

Global initiatives with local solutions

Training and capacity building are well established initiatives on the international agenda in development, science and science. However, in contrast to many capacity building activities, this framework calls for a different approach: rather than implementation 'western' goal and training programmes it calls for sustainable training that has to include local people from the beginning in the design period, building on existing infrastructures and meet local requirements.

Limitations

Lack of specific guidelines

Among the limitations is, however, that this framework requires thinking. It is not applying ticks to pre-set check lists. Its generic nature can be criticised for being non-specific. However, this framework acknowledges that different disciplinary groups (engineers, architects, etc.) have created innovative technical solutions to discrete problems. This framework, however, has a more comprehensive and integrative understanding of biosafety and biosecurity; these concerns cannot be reduced and discussed on a level of isolated technical solutions. For instance, having naturally ventilated labs seem to be a good solution for an environment that has only intermittent access to power and constant climate conditions in laboratories, but a focus on individual technical solutions, such as natural ventilated labs, does not offer solutions

for broader and more complex biosafety and biosecurity. These complex concerns require a different angle.

Hypothetical pilot status of the framework

This framework is a theoretical, pilot framework and thus a draft. It was generated through a thorough analytic and reflective process involving key stakeholders. However, we believe that the application of the framework and the solutions generated with it in the future will add relevant feedback and probably amend- and/or refinements.

Recommendations

This draft framework will be further developed and contextualized. Envisioned are three major steps:

1) Meetings to ***populate*** the framework

- Technical meetings and implementation discussions with technical experts (engineers, architects, scientists, etc.) to *populate* the framework;

2) Briefings to ***popularise*** the approach;

- Briefings and discussion with key policy-makers;
- Further support for countries to take this framework to political fora, international organisations and working groups such as World Health Assembly (WHA), the Global Health Security Agenda and the Global Partnership to gain universal acceptance and support for such an approach.

3) In a next step, this further refined framework should ***promote*** political buy-in and advocate for changes in the laboratory capacity building policy and in funding schemes.

Conclusion

The common practice of exporting costly and complex biocontainment facilities and standards is not sustainable. Concerns about sustained biosafety and proliferation of capabilities that could be misused require careful consideration. The proposed alternative framework for a safer, more secure and sustainable laboratory capacity building can guide capacity building according to local needs (local) with an emphasis on relationship and trust-building (people) and continuous outcome and impact measurement (make sense). This generic framework can and

should serve as a blueprint for international policy decision-making on improving biosafety and biosecurity in laboratory capacity building.

Funding

This work was supported by the UK International Biosecurity Programme and the Global Partnership Programme of the Department of Foreign Affairs, Trade and Development Canada with a project grant to Chatham House ("Safe and secure biomaterials"), grant number 4015-02/Chatham House/LRBS.

Acknowledgement

Chatham House is very grateful for the contributions of representatives from low-, middle- and high-income countries to this debate.

Conflict of interests

The authors declare that they do not have a conflict of interests.

Authors' contribution

PD developed the idea and material for the workshops and wrote the draft manuscript. HS and NL contributed to the workshop and draft manuscript. All authors approve the final version.

References

1. Tran PD, Vu LN, Nguyen HT, Phan LT, Lowe W, McConnell MS, et al. Strengthening global health security capacity - Vietnam demonstration project, 2013. *MMWR* (2014) **63**(4):77-80.

2. Borchert JN, Tappero JW, Downing R, Shoemaker T, Behumbiize P, Aceng J, et al. Rapidly building global health security capacity - Uganda demonstration project, 2013. *MMWR* (2014) **63**(4):73-6.

3. Blazes DL, Bondarenko JL, Burke RL, Vest KG, Fukuda MM, Perdue CL, et al. Contributions of the Global Emerging Infections Surveillance and Response System Network to global health security in 2011. *US Army Medical Department journal* (2013) Apr-Jun: 7-18.

4. Wilson K, von Tigerstrom B, McDougall C. Protecting global health security through the International Health Regulations: requirements and challenges. *CMAJ* (2008) **179**(1):44-8.

5. Rodier G, Greenspan AL, Hughes JM, Heymann DL. Global public health security. *Emerging infectious diseases* (2007) **13**(10):1447-52.

6. (WHO) WHO. *International Health Regulations* (IHR 2005). Geneva: World Health Organization, 2005.
7. [No authors listed] Improving global health, strengthening global security. *Biosecurity and bioterrorism* (2011) **9**(1):73-8.
8. Bakanidze L, Imnadze P, Perkins D. Biosafety and biosecurity as essential pillars of international health security and cross-cutting elements of biological nonproliferation. *BMC public health* (2010) **10** Suppl 1:S12.
9. Caceres SB. Global health security in an era of global health threats. *Emerging infectious diseases* (2011) **17**(10):1962-3.
10. [No authors listed] Meeting of the States Parties to the Convention on the Prohibition of the Development. *Report of the meeting of states parties*. Geneva: 2008 Contract No.: BWC/MSP/2008/5.
11. Centers for Disease Control (CDC). *Principles in Biosafety*. In: CDC, editor. Biosafety in Microbiological and Biomedical Laboratories (BMBL). 5th ed2009.
12. Centers for Disease Control (CDC). Principles of Biosafety. In: CDC, editor. *Biosafety in Microbiological and Biomedical Laboratories* (BMBL) 5th Edition2009.
13. World Organisation for Animal Health (OIE). *Standard for managing biorisk in the veterinary laboratory and animal facilities*. Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 20142014.
14. Public Health Agency Canada (PHAC). *Canadian Biosafety Standards and Guidelines for Facilities Handling Human and Terrestrial Animal Pathogens, Prions, and Biological Toxins*. 2013.
15. Canadian Ministry of Health. *The Laboratory Biosafety Guidelines*. 3rd Edition. 2004.
16. Occupational Safety and Health Administration (OSHA). *Laboratory Safety Guidance.* 2011.
17. Gunther S, Feldmann H, Geisbert TW, Hensley LE, Rollin PE, Nichol ST, et al. Management of accidental exposure to Ebola virus in the biosafety level 4 laboratory, Hamburg, Germany. *The Journal of infectious diseases* (2011) **204** Suppl 3:S785-90.
18. Centers for Disease Control (CDC).. *Report on the Inadvertent Cross- Contamination and Shipment of a Laboratory Specimen with Influenza Virus H5N1*. CDC website: CDC, 2014 15/08/2014. Report No.
19. Centers for Disease Control (CDC).. *Report on the potential exposure to Anthrax*. CDC website: 2014.

20. Centers for Disease Control (CDC).. *Report on the Potential Exposure to Ebola Virus*. CDC website: CDC, 2015.

21. [No authors listed] Foot and mouth: mystery outbreak at Pirbright. *Nature* (1970) **228**(5270):403.

22. [No authors listed] *Report of the Investigation into the Cause of the 1978 Birmingham Smallpox Occurrence* (22 July 1980). London: Her Majesty's Stationary Office, 1980.

23. External Laboratory Safety Workgroup (ELSW). *Recommendations of the Advisory Committee to the Director Concerning Laboratory Safety at CDC*. 2015 13/01/2015. Report No.

24. European Commission for the Control of Foot-and-Mouth Disease. *Minimum biorisk management standards for the laboratories working with Foot-and-Mouth Disease*. 2013.

25. Bielecka A, Mohammadi AA. State-of-the-art in biosafety and biosecurity in European countries. *Archivum immunologiae et therapiae experimentalis*. (2014) **62**(3):169-78.

26. Blaine JW. Establishing a national biological laboratory safety and security monitoring program. *Biosecurity and bioterrorism* (2012) **10**(4):396-400.

27. Dickmann P, Apfel F, Biedenkopf N, Eickmann M, Becker S. Marburg biosafety and biosecurity scale (MBBS): a framework for risk assessment and risk communication. Health Security. 2015;**13**(2):88-95.

28. Daniels P, Poermadjaja B, Morrissy C, Ngo TL, Selleck P, Kalpravidh W, et al. Development of veterinary laboratory networks for avian influenza and other emerging infectious disease control: the southeast asian experience. *EcoHealth*. 2014;**11**(1):44-9.

29. Gilpin TMSC. A Risk Assessment-based Approach to Defining Minimum Biosafety Precautions for Tuberculosis Laboratories in Resource-limited Settings. *Applied Biosafety*. 2012;**17**(1):6-10.

30. Oladeinde BH, Omoregie R, Odia I, Osakue EO, Imade OS. Biorisk assessment of medical diagnostic laboratories in Nigeria. *Safety and health at work*. 2013;**4**(2):100-4

31. Callaway E. Biosafety concerns for labs in the developing world. *Nature* (2012) **485**(7399):425.

32. Andrus JK, Aguilera X, Oliva O, Aldighieri S. Global health security and the International Health Regulations. *BMC public health* (2010) **10** Suppl 1:S2.

33. Feldbaum H, Patel P, Sondorp E, Lee K. Global health and national security: the need for critical engagement. *Medicine, conflict, and survival* (2006) **22**(3):192-8.

34. Inglesby T, Fischer JE. Moving ahead on the global health security agenda. *Biosecurity and bioterrorism* (2014) **12**(2):63-5.

35. Katz R, Sorrell EM, Kornblet SA, Fischer JE. Global health security agenda and the international health regulations: moving forward. *Biosecurity and bioterrorism* (2014) **12**(5):231-8.
36. Gostin LO, Phelan A. The global health security agenda in an age of biosecurity. *JAMA* (2014) **312**(1):27-8.
37. Lightfoot N, Santhakumar A, Rashid S, Lishi Li H. *Safe and secure biomaterials: matching resouces to reality*. Chatham House Background Paper. London Chatham House, 2013.
38. Dickmann P, Emami S, Santhakumar A, Mildenberger C, Lightfoot N. *Safe and Secure Biomaterials. A Risk-Based Alternative Approach*. London: Chatham House, 2014.

V. Evaluation framework for public health interventions

MAKING SENSE OF COMMUNICATION INTERVENTIONS IN PUBLIC HEALTH EMERGENCIES – an evaluation framework for risk communication[25]

Abstract

Introduction: Communication interventions during public health emergencies are acknowledged as a determinant of success in preparedness, response and recovery. However, there is little evidence on the impact of communication interventions upon the dynamics of public health emergencies to guide capacity development.

Hypothesis: This article proposes a new evaluative framework built on the hypothesis that impact is measureable through the evaluation of identifiable performance parameters related to the dynamics of an outbreak. The assumption is that risk communication interventions that lead to earlier detection, faster response, smoother coordination and a smarter legacy lead to lower morbidity and mortality (reduced $AUC_{epidemic\ curve}$).

Method: This new evaluation framework for risk communication measures the relation between a baseline dynamic of epidemic and communication activities and the changed dynamic resulting from risk communication activities.

Conclusion: A better understanding of how the two dynamics relate can lead to a better management of future public health emergencies.

Keywords: Risk communication, Measurement, Evaluation, Infectious Diseases, Preparedness planning, Infectious Disease Management, Public Health Interventions

Introduction

The public health imperative during an outbreak of an infectious disease is to control the event as quickly as possible in order to protect health and minimize the loss of life and disruption caused by an epidemic.[1] The opportunity for rapid control of outbreaks is most effective if the

---

[25] Petra Dickmann, Amanda McClelland, Gaya M Gamhewage, Patricia Portela de Souza, Franklin Apfel (2015): Making sense of communication interventions in public health emergencies - an evaluation framework for risk communication. Journal of Communication in Healthcare 2015; 8(3), 233-240. DOI: 10.1080/17538068.2015.1101962

outbreak is detected early and appropriate responses are initiated quickly.[2] Communication, social mobilization and the early sharing of information have been found to play a critical role in prevention and preparedness, outbreak control and recovery.[3] Infectious disease prevention and control need to be fast, flexible and effective. Delays in information sharing, miscommunication and/or misinterpretation between those affected, response staff and volunteers, public health officials, policy makers, and businesses can affect health, livelihoods and economic stability.[4,5] The current outbreak of Ebola virus in West Africa underlines the importance and complexities of communicating at all levels: between international and national agencies, national and local health authorities and community-based organizations, front line health workers and affected population, and affected communities themselves.[6] Slow and poorly coordinated international and national responses, weak surveillance and reporting systems, low provider knowledge and capacity, lack of sensitivity to local beliefs, norms and values, poor engagement with affected populations, and low levels of trust in authorities and experts are some of the communication related difficulties identified.[7,8]

Communication activities related to epidemic outbreaks work best when they build on a comprehensive understanding of infectious disease risks among and between health officials, affected or vulnerable communities and the general public. Risk communication activities are aimed at identifying, describing, analysing, addressing and adopting the behavioural, knowledge and attitudinal factors that underpin the more efficient and effective management of infectious disease risks.[9] Those responsible for preparing, preventing and responding to an outbreak need to understand the socio-cultural perceptions, views and practices of those at risk of harm from the public health hazard and work in a way that builds and maintains trust. Trust is seen as a fundamental component of outbreak control across cultures.[3]

Institutionalised risk communication capacities and systems help prepare for crisis management and in so doing build capacity for needed understanding of infectious disease risks and related behaviours. This capacity building is vital both for peaks in demand and public health emergencies, and also for managing continuous health threats, such as measles outbreaks and antimicrobial resistance.[10]

However, while the importance of risk communication in public health interventions is increasingly acknowledged and embraced e.g. as a core capacity in the WHO IHR 2005, no standardized measurement tools have been agreed to evaluate the impact of risk communication activities upon unfolding infectious disease emergencies and continuous threats. Our measurement hypothesis aims to contribute to the development of an evaluation framework that addresses a broader conceptualisation of risk communication activities

including planning, preparedness, response and recovery phases. Without tools to evaluate the impact of risk communication it is not possible to make evidence-based recommendations for good practise or justify investments.[11-13]

A new approach to risk communication in public health

Researchers have used before and after measures, various models and data sources to estimate how much difference in awareness, choice and behavioural patterns, a given risk communication intervention has made for a particular outbreak.[14-16] These measurements have been built on approaches to risk communication that mainly focussed on the need to find the right way to tell people what to do in times of a crisis. Such approaches are important, but do not reflect current thinking and concerns about the limitations of just focussing on uni-directional, hierarchical information conveyance from health officials to the public.[9,17] Risk communication is now understood as a more interactive, holistic, continuous and engaging activity that focuses on dialogue, intelligence gathering, building relationships over time, a knowledge base informed by new and accessible communication technologies (e.g., social media and networks), and supportive environments. Risk communication is now viewed more broadly and includes information, communication and coordination activities.[10,18]

Information

Information activities include but are not limited to intelligence gathering, assessing and sharing. Importantly, this also includes listening capacity through formative research (focus groups, interviews, questionnaires), media monitoring, public opinion polls, networking, use of media- traditional and social, surveillance and laboratory diagnostic systems.

Communication

Communication activities include but are not limited to content development (key messages), segmentation approaches (strategy) and delivery methods (channels and spokespeople). This also includes relationship building, dealing with uncertainty, building trust, transparency, engagement strategies and consultation.

Coordination

Coordination activities include but are not limited to partnership and inter-sectoral working, ensuring congruent messaging, internal communications and collective endorsements. Coordination takes place on different geographical and organisational levels and includes developing supportive environments, e.g., developing health literacy friendly organisations and communities; - aligning literacy demands with skills

of users; providing navigational assistance in complex systems; and use of community champions.

Box 1: Risk communication - key terms and their working definitions

A Risk communication matrix

To take account of this conceptual shift in the understanding of risk communication, a new measurement approach is proposed which has a broader activity focus than just information transfer and communication of risks. The new approach looks at three main activity areas of risk communication across the lifecycle of an epidemic. These activity areas include:

- Listening and gathering insights, assessing and sharing: e.g. monitoring social media chats or performing formative research to better understand perceptions, attitudes, knowledge and behaviours of vulnerable and other populations;
- Communicating and engaging: e.g. making reliable, up-to-date information available and accessible; selecting appropriate trust-worthy communicators, platforms and channels for distribution of information; integrating key stakeholders into planning and dissemination activities; and
- Coordinating, supporting and reviewing: e.g. building and supporting on-going relationships with stakeholders and partners; monitoring and evaluating performance parameters and adjusting practise based on learning.

Risk communication activities		BEFORE a public health emergency PREPAREDNESS	BEGINNING a public health emergency DETECTION/ALERT	DURING a public health emergency RESPONSE	AFTER a public health emergency RECOVERY
Informing *Listening*	**Gathering**				
	Assessing				
	Sharing				
Communicating *Relationship building*	**Communications (actions: flyer, website, etc.)**			Crisis communication	
	Key messages / Content				
	Strategy / Methods				
Coordinating *Supportive environments*	**District**				
	Regional				
	National				
	International				

Figure 1: Matrix of risk communication typology [adopted from [10]]

Figure 1 creates a matrix of risk communication typology that focuses on these three activity areas and can be used to help structure evaluative thinking related to these activities during the key phases of public health emergencies and could serve as a template or resource for planning. It also places crisis communication within the matrix of risk communication activities and helps identify the more limited focus of crisis communication and its positioning in the spectrum of risk communication activities.[11]

An evaluation hypothesis

Building on this activity matrix, it is hypothesised that an effective measurement approach should help to better understand if and how risk communication interventions affect the dynamic of a public health infectious disease emergency; for example, an outbreak.

The epidemic and communication curves

To understand how this might work, it is useful to compare typical epidemic and communication related curves in the lifecycle of an epidemic (see Figure 2 where the curves are used as models for illustration purposes).

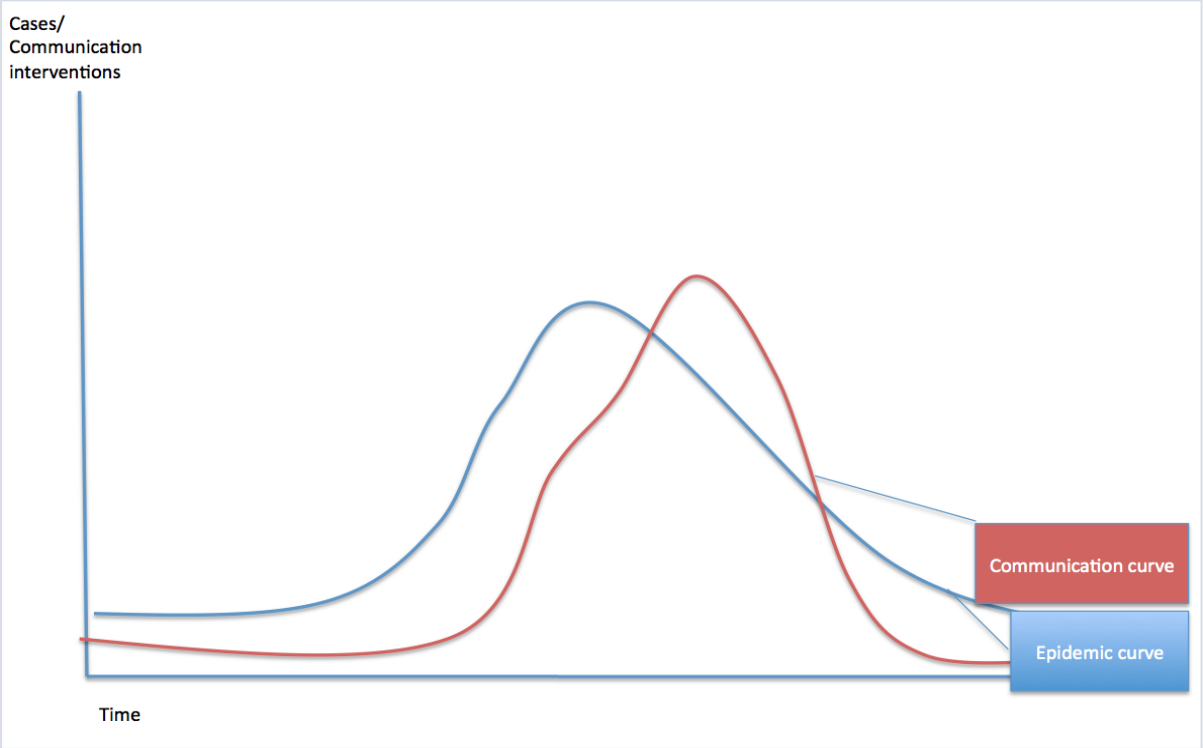

Figure 2: Normal distribution of epidemic curve and communication curve

Communication interventions usually come in when the epidemic outbreak is detected by surveillance and response interventions and outbreak control measures are triggered and implemented. Four key performance parameters are identified.

First, in the routine epidemic situation, there is a time lag between the onset of the outbreak and its detection (1) and the activation of communication activities for response (2). Thirdly, it usually takes a while until the outbreak is reported to national and international level (e.g., WHO under IHR or ECDC under EU legislation) in order to comply with national and international health regulations, request further assistance in the management of an epidemic outbreak and/or coordinate the national and international response (3). The post-epidemic recovery period provides another key performance parameter. In this period lessons, often neglected, could be learned that lead to better preparedness and improved response for future epidemic outbreaks. We call this leaving a "legacy" because we see this as a process that uses learning to build knowledge and response capacity in the community and health systems to improve performance. This is the fourth performance parameter (3). This could, for example, refer to new and or improved processes and systems that may be established by specific teams in managing epidemics and emerging diseases outbreaks that consequently become sustainable, institutionalized and used by subsequent/future teams.

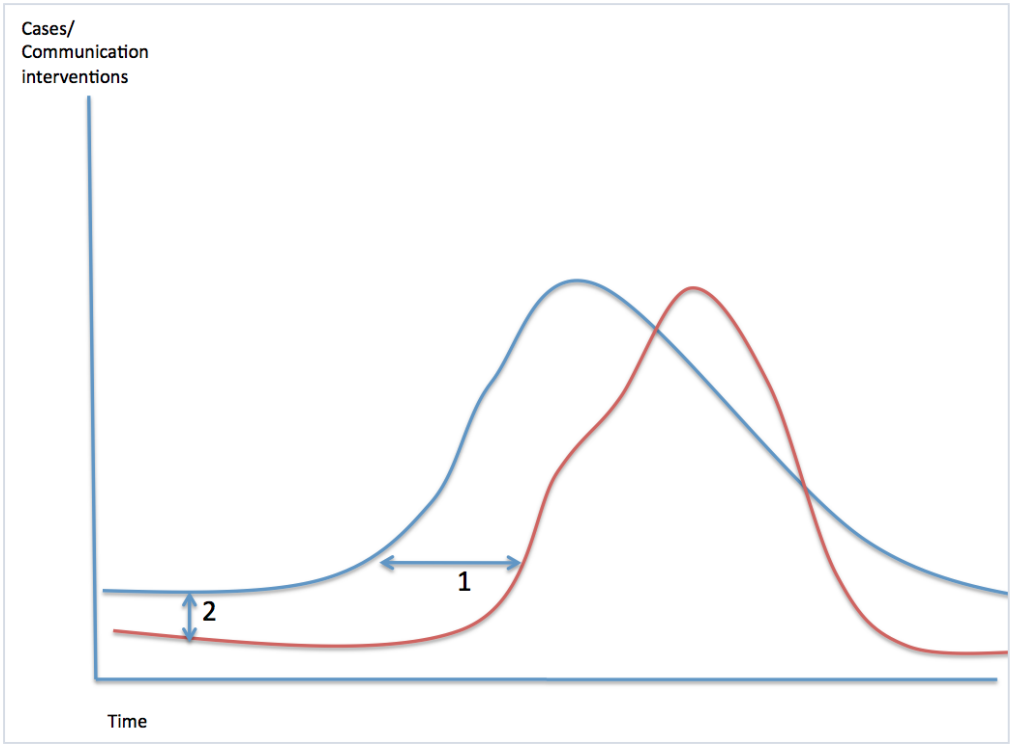

Figure 3: Key performance areas

Hypothesis

The proposed measurement approach focuses on the relation between a baseline dynamic of epidemic activities and communication activities and the changed dynamic resulting from risk communication activities. Performance parameters are identified that could eventually be measured by their impact on better case management, lower infection attack rate, fewer cases, fewer deaths, increased compliance, etc. The overall goal and long-term outcome is that improved communication interventions will lead to improved management of public health events and a reduction of morbidity and mortality (reduced $AUC_{epidemic}$). (Figure 4)

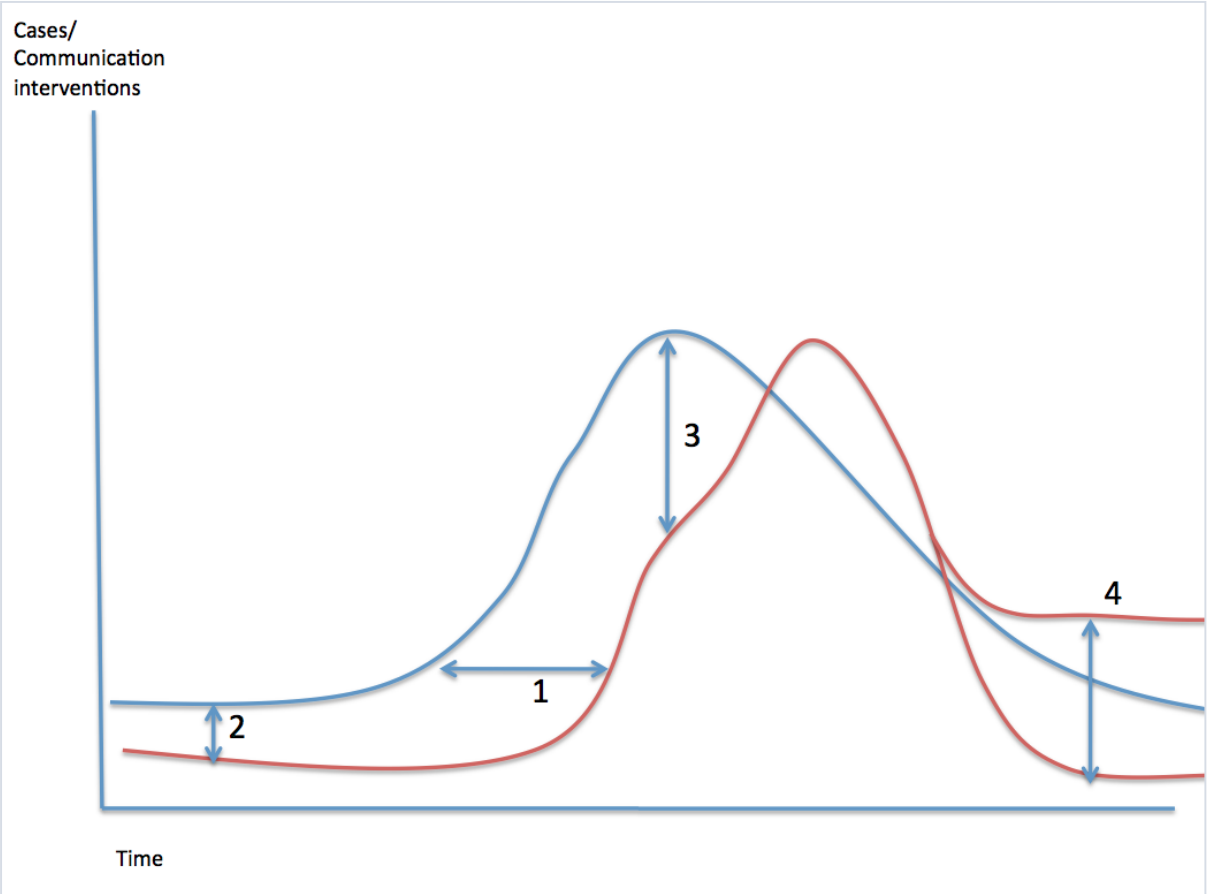

Figure 4: Improved communication may have a positive impact on the course of the epidemic (hypothesized)

Evaluating communication activities: Four key performance parameters

This proposed approach to the evaluation of risk communication activities draws on a new understanding of risk communication and measures the relationship(s) between the dynamic of the epidemic or incident and the dynamic of communication and social mobilization interventions that reflect risk communication response capacity.

For an initial core conceptual framework we focus on four key performance parameters that can be described as:

- EARLIER (1): reducing the time lag between onset of outbreak and its detection by getting closer to and more engaged with the community and the infectious activities on the ground
- FASTER (2): reducing the time lag between detection and response activities
- SMOOTHER (3): better coordination of national and international response activities
- SMARTER (4): feeding back to improve decision-making and response in the current event and leaving a legacy to improve preparedness, control, response and recovery for future outbreaks

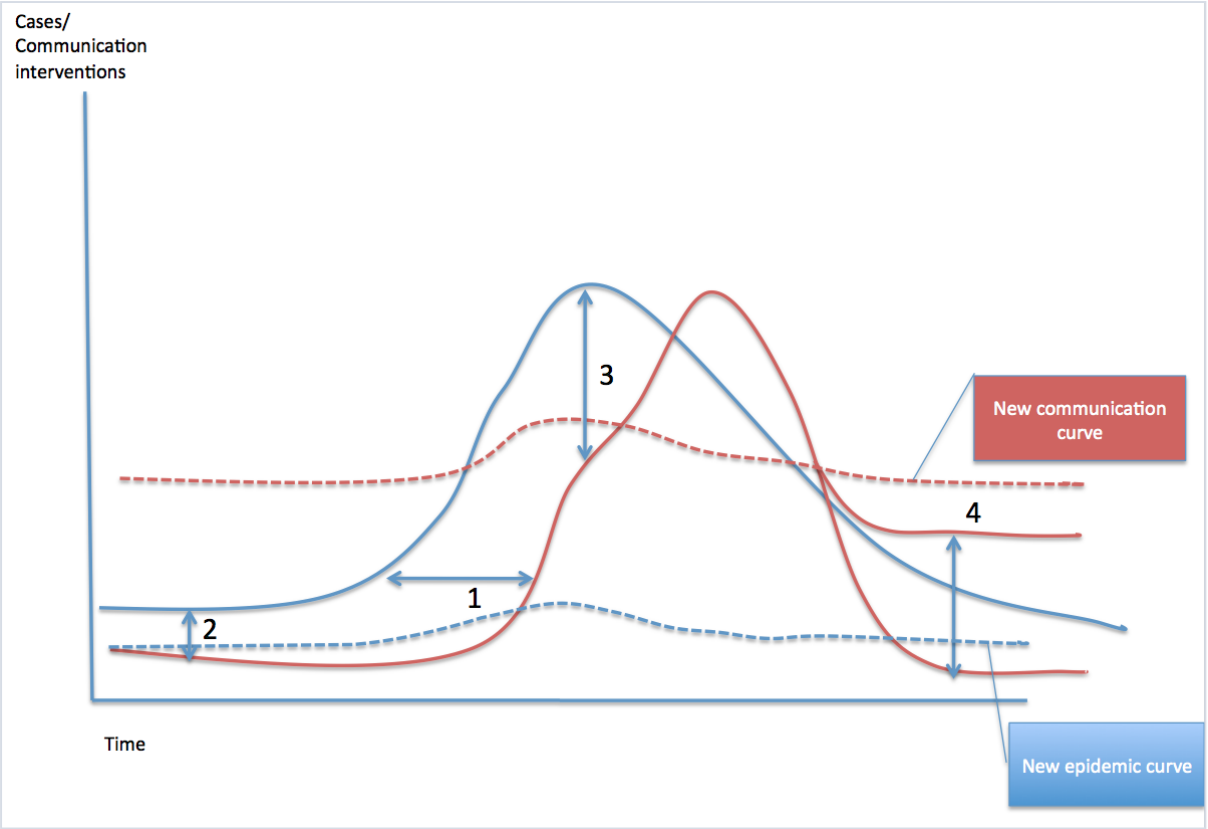

Figure 5: Key performance areas EARLIER, FASTER, SMOOTHER, SMARTER

EARLIER

All activities, conditions and factors in the areas of information, communication and coordination that lead to earlier detection, such as closer relationship with communities, improved first detector capacity, trust in reporting cases, listening to rumours, etc.

FASTER

All activities, conditions and factors in the areas of information, communication and coordination that lead to faster response, such as reducing the time from realisation of an outbreak to initiating response by having trusted information and communication networks, trained and knowledgeable workforce, existing communication between communities and health professionals.

SMOOTHER

All activities, conditions and factors in the areas of information, communication and coordination that lead to smoother coordination, such as better collaboration between sectors, trusted information sharing and communication between different administrative levels, better link between national and international response approaches.

SMARTER

All activities, conditions and factors in the areas of information, communication and coordination that lead to smarter legacy, such as a feedback mechanisms to enable and encourage learning from previous events, improved information sharing and communication for better decision making, more resilient communities, etc.

Box 2: Key performance areas – key terms and working definitions

Measurement approach: process and outcome measurement

Aiming to assess impact, researchers in the fields of social sciences, e.g. communication interventions, are often faced with the attribution problem: a positive impact, e.g. fewer death or a lower mortality, cannot be attributed to – for example – a specific communication intervention programme that promotes the adoption of risk–reducing behaviour, because of confounding factors that may have contributed to the desired impact.

This measurement framework suggests a different approach: it can be used for process and outcome measurement. The four key performance areas can be used in a process evaluation to monitor and assess how risk activities (see Figure 1) have changed. Risk communication process measurement, for example, could focus on the "how" of risk communication interventions, e.g. how the risk communication is being performed. Key questions here could include: is this risk communication activity aimed at getting closer to communities; how does it do it? (The 'how' question elucidates context-sensitive indicators to be used in the measurement).

This conceptual framework can also be used to measure outcomes of risk communication interventions and their impact on performance ("EARLIER", "FASTER", "SMOOTHER" and

"SMARTER".) in the activity areas of information, communication and coordination (Figure 1). For example, in the performance area of "EARLIER" and "FASTER", risk communication information gathering interventions could be aimed at creating a new or better link with a community group that shares information related to its "listening" to community concerns and beliefs on a regular basis. Better engagement with such community groups could result in earlier recognition of an event and faster reporting. Earlier detection and faster reporting could be facilitated because people are more aware, comfortable to report and know better whom to contact in case they detect anything unusual. An outcome measurement using the key performance areas could measure a change in outcome before and after a risk communication intervention programme. This is why this measurement framework uses comparatives for its performance areas ("EARLIER", etc.). These changed outcomes can indicate how they contribute to the desired impact.

Similarly, "SMOOTHER" could relate to better coordination between sectoral departments and "SMARTER" to evidence showing that relevant processes and systems have been changed based on learning.

Modelling – Understanding the relation between the two dynamics

While the measurement of changes in the relation between two dynamics seems rational, the key challenge in this approach is how to translate risk communication activities into measurable data. For this purpose, historic events, such as past outbreak data (e.g. Cholera outbreak in Sierra Leone 2012), can be used to pilot a first categorisation of risk communication activities (outputs) e.g. number of household visits, information campaigns, number of volunteers, on-going and ad hoc activities in the countries, etc. into the typology of risk communication activities (Figure 1) and understand how these activities lead to changed outcomes: earlier detection, faster response, smoother coordination and a smarter legacy. These historic events are well documented by international aid agencies and could form a starting point to look at risk communication activities in the context of different disease outbreaks (such as Cholera, Ebola) in different geographic settings. Risk communication could then be combined with formal mathematical models of infectious disease outbreaks to better understand the two dynamics. A variety of other, equally well-documented outbreaks, e.g. current Ebola outbreak in West Africa, could be used to develop the tools for this measurement approach as well.

Perspective

There is no internationally agreed approach to the measurement of public health communication interventions in the context of infectious disease emergencies. Researchers and practitioners work hard to improve emergency response and justify investments.

If and how public health communication interventions affect the epidemic course is still under-researched and how approaches are selected still tends to be somewhat intuitive. In order to move towards the ability to reliably measure impact of risk communication interventions our proposed framework provides a system that can contribute to a better understanding on how risk communication interventions contribute to changing key performance parameters that can be associated with reductions in deaths and illness.

We believe that the key performance area "SMARTER" deserves more attention as it is often neglected in processes that predominantly focus on improving detection and response. "SMARTER" performance includes both the capacity to feedback, in real-time; lessons being learned from an on going outbreak to improve decision-making and communication; and inform and improve, based on new knowledge and experience gained, future preparedness, prevention, response and recovery from other health events. Such "SMARTER" processes and outcomes leave a "legacy" that can give communities a greater ability to cope and strengthen their resilience for future health risk.

The analytical approach now being proposed has been developed to better understand the dynamics of public health interventions in different socio-cultural settings. Research has now to focus on gaining a better understanding of this contextual relationship. We believe that applying our measurement approach will be helpful to such research endeavours. We recommend the use of this framework in any analytic research setting exploring the impact of risk communication interventions. The recent Ebola outbreak seems like an obvious starting point as the learning curve about the importance of communication and community engagement seems very steep.

Acknowledgement

This hypothesis idea as presented here was first developed during a consultation meeting in Geneva (December 2012) on invitation of IFRC together with WHO and UNICEF. Since that time it has been further developed during a risk communication training at the Rockefeller Bellagio Center in July 2013 for Connecting Organizations for Regional Disease Surveillance (CORDS), funded by the Rockefeller Foundation; and in the context of an European Centre for Disease Prevention and Control (ECDC) project to develop an "Evaluation Framework for

Risk Communication" (06/2013 – 01/2014). The outcomes of Bellagio training (templates and scenarios for evaluating risk communication activities) will be published shortly. The ECDC work applied the original measurement idea on a multi-country risk communication mapping and a pre- and post-training assessment in risk communication (four Baltic countries plus Sweden, Tallinn October 2013) in an effort to elaborate an evaluation framework to benchmark risk communication performance. Outcomes of this project, including mapping questionnaires, training assessments and the evaluation framework to benchmark risk communication will be published shortly.

Conflicts of interests

The authors declare that they do not have any conflicts of interests related to this publication

References

1. Smith RD, Keogh-Brown MR, Barnett T, Tait J. The economy-wide impact of pandemic influenza on the UK: a computable general equilibrium modelling experiment. BMJ. 2009; 339:b4571.

2. Heymann DL, Dar OA. 3. BMJ. 2014; 348:g1499.

3. World Health Organization (WHO). WHO Outbreak communication guidelines. World Health Organisation. Geneva: 2005.

4. Fineberg HV. Pandemic preparedness and response--lessons from the H1N1 influenza of 2009. NEJM. 2014; 370(14):1335-42.

5. Smith RD. Responding to global infectious disease outbreaks: lessons from SARS on the role of risk perception, communication and management. Soc Sci Med. 2006; 63(12):3113-23.

6. Green A. West Africa struggles to contain Ebola outbreak. Lancet. 2014; 383(9924):1196.

7. Kutalek R, Wang S, Fallah M, Wesseh CS, Gilbert J. Ebola interventions: listen to communities. Lancet Glob Health. 2015;3(3):e131.

8. Chandler C, Fairhead J, Kelly A, Leach M, Martineau F, Mokuwa E, et al. Ebola: limitations of correcting misinformation. Lancet. 2015;385(9975):1275-77.

9. Dickmann P. Introducing a new risk communication paradigm: Petra Dickmann. EJPH. 2013; 23(suppl 1).

10. Dickmann P, Abraham T, Sarkar S, Nurm Ü, Wysocki P, Cecchoni S, et al. Conceptualising and teaching risk communication as a core public health competence in infectious disease management: developing the ECDC training curriculum and programme. Eurosurveillance (accepted).

11. Moore G, Audrey S, Barker M, Bond L, Bonell C, Cooper C, et al. Process evaluation in complex public health intervention studies: the need for guidance. J Epi Com Health. 2014; 68(2):101-2.
12. Forssman B, Gupta L, Burgess G. A case study of the evaluation of a public health intervention. Australian Health Review. 2006; 30(4):458-61.
13. Campbell M, Fitzpatrick R, Haines A, Kinmonth AL, Sandercock P, Spiegelhalter D, et al. Framework for design and evaluation of complex interventions to improve health. BMJ. 2000; 321(7262):694-6.
14. Rubin GJ, Amlot R, Page L. The London polonium incident: lessons in risk communications. Health Physics. 2011; 101(5):545-50.
15. Rogers MB, Amlot R, Rubin GJ, Wessely S, Krieger K. Mediating the social and psychological impacts of terrorist attacks: the role of risk perception and risk communication. Int Review Psy. 2007; 19(3):279-88.
16. Rubin GJ, Page L, Morgan O, Pinder RJ, Riley P, Hatch S, et al. Public information needs after the poisoning of Alexander Litvinenko with polonium-210 in London: cross sectional telephone survey and qualitative analysis. BMJ. 2007; 335(7630):1143.
17. Campbell C, Scott K. Community health and social mobilization. In: Obregon R. and Waisbord S (eds.). The Handbook of Global Health Communication 2012; Wiley-Blackwell, Chichester UK: 177-194.
18. Neiger BL, Thackeray R, Burton SH, Giraud-Carrier CG, Fagen MC. Evaluating social media's capacity to develop engaged audiences in health promotion settings: use of Twitter metrics as a case study. Health Promotion Practice. 2013; 14(2):157-62.

VI. Case Study: EBOLA

USING LESSONS LEARNED FROM PREVIOUS EBOLA OUTBREAKS TO INFORM CURRENT RISK MANAGEMENT[26]

Connecting Organizations for Regional Disease Surveillance (CORDS), together with the Southern African Centre for Infectious Disease Surveillance, organized an emergency meeting (September 1–2, 2014, in Dar es Salaam, Tanzania) to gather and collate first-hand experience from past Ebola outbreaks. The major aim was to identify key lessons that could inform current risk management. This meeting brought together a unique assembly consisting of scientists, policymakers, community and religious leaders, traditional healers, and media representatives from eastern and central Africa. They elucidated 3 major lessons that focus on improving communication, working with communities, and building and strengthening local capacity.

Communication: Work with Communities, Not against Them

A major conclusion was that infectious disease management will work only when it is established with and within the community and not directed against it. This lesson requires community engagement in formulating infection control measures, as well as implementation, dissemination, and promotion of these measures. Infection control procedures are generally perceived as intrusive and, as such, often interfere with local social, cultural, and religious practices. For instance, the recommendation to avoid physical contact with a sick person is simply outside the behavioural norms in most communities. For example, from a community perspective, "protect yourself when caring for a sick person" would be a more suitable recommendation and a better alternative than a recommendation to avoid all physical contact. Building on this process of finding the right, appropriate containment measures, communication and health promotion work best when they involve community and religious leaders, traditional healers, and other advocates.

National and cross-border Ebola outbreaks are a new development, and engagement with various communities has presented a particular challenge throughout the current outbreak. A

[26] Petra Dickmann, Andrew Kitua, Paul Kaczmarek, Julius Lutwama, Justin Masumu, Esron Karimuribo et al. (2015): Using Lessons learned from previous Ebola outbreaks to inform current risk management. Emerging Infectious Diseases 05/2015, 21(5): DOI: 10.3201/eid2105.142016

key aspect of this engagement is to devise and elaborate solutions for infection control that are consistent with local realities and practices. International health and aid organizations must strive to work in concert with communities to find adequate infection-control solutions.

Communication: Share Early, Listen to Beliefs, and Read Rumours

Early sharing of information and surveillance data among professional groups was considered to lead to clear benefits. The countries of central and eastern Africa learned from previous outbreaks, and they have established infectious disease surveillance networks that operate in cross-border regions. Training in risk communication and One Health promote early communication among neighbouring professionals across sectors and with the public. Multi-sectoral collaboration is key to early detection and faster response.

The risk communication approach also encourages public health professionals to engage with their communities to gain a better understanding of community values, opinions, and beliefs. For instance, a major lesson involved burial practices: participants explained that for local persons, a traditional burial is more essential than protecting themselves from an infectious disease they have not yet encountered. Therefore, the well-intended infection control messages went unheeded because they were not perceived to be relevant to completing a sacred ritual.

Traditional burial practices can hardly be stopped through the imposition of infection control measures ("Don't touch/wash"), but they could be made safer by integrating protective steps into the rituals, such as using gloves and burying the deceased rapidly. International organizations might need to redesign their communication strategy to prioritize the communities' needs, not their own requirements.

Communities have their own communication networks, and rumours spread fast and are influential. Regarding infectious disease, there are 2 kinds of rumours: 1) about possible cases (alerts) and 2) about community explanations of causes. Rumours distract from (compete with) the health message. Outcomes from this meeting suggest reframing rumours as useful guidance similar to pain, rumours provide often uncomfortable but useful feedback. The 2 main types of rumours are useful indicators to for 1) guiding case detection and 2) understanding where communication efforts go wrong. This reframing might enable health experts to detect cases earlier and to more effectively communicate with the public; it could also encourage a discourse about unusual disease events within communities.

Speaking from experience, public health experts advised communication specialists to consider using a case alert rumor book to provide alarm signals for quick response and follow-up response. In addition, a rumor book could serve as a record of the community explanations of

infectious disease transmission and, as such, might help establish a starting point for community engagement. For instance, a common rumour was that Ebola is caused by witchcraft; the conventional response is to refer to Ebola as a virus. However, more useful would be to accept this alternative explanation and create recommendations consistent with community mind-set (e.g., don't touch this person unprotected, but provide food [and prayers] as a token of empathy).

Capacity Building: Avoid Blind Spots by Addressing the First Detectors

Cases typically appear before medical attention is sought and thus before cases can be understood as useful signals that trigger the activation of response. The initial detections of cases as alarm signals in a community represent the "blind spots" of capacity building: 1) capacity building on local level is often for health professionals, and 2) capacity building addresses a response mechanism (first responder training). Avoiding blind spots means shifting capacity building from reactive response to proactive detection involving the community.

Awareness raising and capacity building capacity at local levels must be continuous. For these purposes, a variety of training is now offered (World Health Organization and Centers for Disease Control and Prevention safety training). CORDS has designed an Intensified Preparedness Programme that offers short-term crisis response and longer term capacity building, consisting of training, advice, and background material for infectious disease management for affected and not-yet affected countries.

Conclusions

The massive influx of international support addresses the foundational weaknesses of the public health systems. A key impairing factor, the engagement and communication with the community, is probably not yet addressed properly. The lessons learned in previous outbreaks identify major drivers of infection control as local realities and can advise the revision of the international response strategy with a focus on community engagement, communication, and capacity building. Effective community engagement during risk communication is a necessary and often underrated strategy to build trust and confidence for community health security and thereby global health security.

Acknowledgments

We thank the National Institute for Medical Research in Dar es Salaam for generously hosting this meeting and providing logistical support.

The authors represent the international nongovernmental organization CORDS (P.D., P.K., N.L.) and 2 of its 6 networks: the Southern Africa Centre for Infectious Disease Surveillance (J.M., E.K., Y.K., A.K., M.R.), and the East African Integrated Disease Surveillance Network (J.L.).

Funding

This meeting was supported by a grant to CORDS from the Rockefeller Foundation.

VII. Risk communication put in practice: EARLIER detection

DRIVERS FOR EARLIER DETECTION – a systematic literature review[27]

Abstract

Background: Early detection of infectious disease outbreaks can reduce the ultimate size of the outbreak with lower overall morbidity and mortality due to the disease. Numerous approaches exist with the aim of detecting outbreaks earlier, and methods have been developed to measure progress on timeliness. Understanding why these surveillance approaches work and don't work will elucidate key drivers of early detection, and can guide interventions to achieve *earlier* detection. Without clarity about necessary conditions for earlier detection and their influencing factors, attempts to improve surveillance will be ad-hoc and unsystematic.

Methods: We conducted a systematic review using the PRISMA framework to identify research published January 1, 1990 - December 31, 2015 in English language. MEDLINE (PubMed) database was searched. Influencing factors were organized according to a generic five-step infectious disease detection model.

Results: Five studies were identified and included in the review. These studies evaluated the effect of electronic-based reporting on detection timeliness, impact of laboratory agreements on timeliness, and barriers to notification by general practitioners. Findings were categorized as conditions necessary for earlier detection or factors that influence whether or not these conditions can be in place, and organized according to the detection model. There is some evidence on reporting, no evidence on assessment, and a speculation about local level recognition.

Conclusion: Despite significant investments to detect outbreaks early, there is very little evidence with respect to factors that influence earlier detection. To guide intervention planning, more research is needed.

Keywords: Infectious Disease Outbreaks, Public Health Surveillance, Disease Notification, Time Factors

---

[27] Lindsay Stelle, Emma Orefuwa and Petra Dickmann (2016): Drivers of Earlier Infectious Disease Outbreak Detection: A systematic literature review. International Journal of Infectious Disease 53:15-20.

Background

Infectious disease outbreaks can spread rapidly, causing enormous losses to individual health, national economies, and social wellbeing.[1-6] Through early detection of an infectious disease outbreak, a small outbreak can potentially be contained at the local level, thereby reducing adverse impacts.[7-11] Early detection has been and remains the current narrative of infectious disease surveillance.

A variety of surveillance approaches exist with the aim of detecting early, many of these following advances in technology. Traditional indicator based surveillance (IBS), e.g. mandatory disease-specific notification, laboratory surveillance, and syndromic surveillance, has been complemented by event based surveillance (EBS) that gathers and analyzes information from drivers, formal or informal,[12, 13] in order to broaden the scope of surveillance to an all hazard approach as requested by International Health Regulations (2005) (IHR) and with the aim to detect outbreaks earlier and faster using new technologies.

Over the last decade, there has been substantial investment in the development and operation of surveillance systems that use existing health data both formal and ad hoc—from sources such as emergency department visits and sales of pharmaceuticals—to provide immediate analysis and feedback to those charged with investigating potential outbreaks.[14] New digital data streams for infectious disease surveillance have risen from developments in information communication technology,[15] such as early adopters ProMED-mail and Global Public Health Intelligence Network (GPHIN), and more recently, numerous openly available news aggregators and visualization tools.[16] Diagnostics have progressed as a result of scientific developments, leading to automation and highly multiplexed assays and advances in point-of-care testing, making sample collection and testing possible in remote settings.[17]

Innovative governance structures have been established to promote early detection. Disease surveillance networks have formed, such as the World Health Organization's (WHO) Global Outbreak Alert and Response Network (GOARN), combining human and technical resources around the world to rapidly identify, confirm, and respond to outbreaks. Cross-border regional disease surveillance networks have been established across the globe, connecting epidemiologists, scientists, ministry officials, health workers, border officers, and community members to engage in activities, such as training, capacity-building, and multidisciplinary research.[18] Agreements have been instituted setting legal mandates around surveillance

activities, such as the IHR (2005), which calls for all WHO Member States to build, improve, and strengthen their capacity to prevent, detect, and respond to infectious diseases outbreaks that can have global spread.[19]

The proliferation of zoonotic diseases has demonstrated that the timely identification of future emerging microbial threats requires an integrated international approach to disease surveillance. Programs working at the human-animal interface employ many of the same techniques as human health, such as the Global Avian Influenza Network for Surveillance (GAINS) that trains individuals and organizations to collect samples, and disseminates lab results through an open-access electronic database.[7]

The list of novel strategies described above is not exhaustive, yet demonstrates the breadth and intricacy of surveillance approaches aiming to detect outbreaks early. These approaches work in concert with generic infectious disease surveillance activities, which remain essential to public health practice, particularly at the local level.[7] Together, these approaches ultimately aim to decrease the impact of outbreaks on populations. (Figure 1).

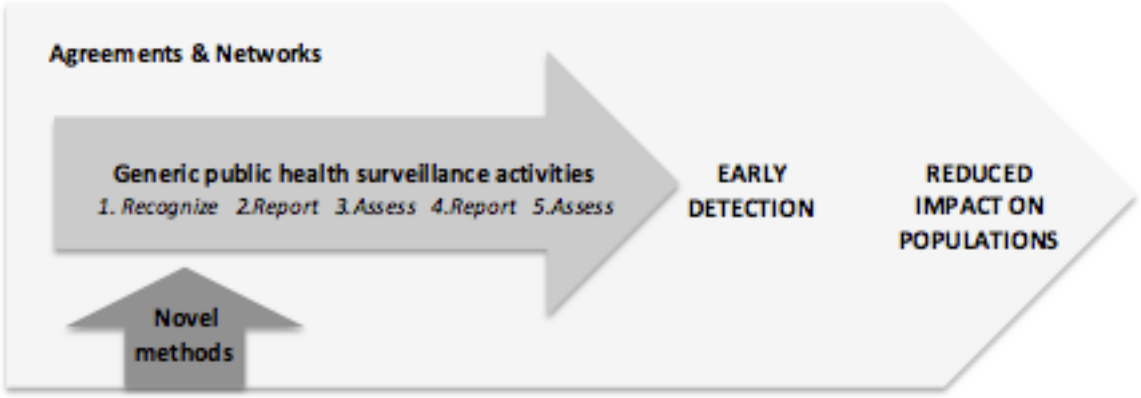

Figure 1. Landscape of approaches for early detection of infectious disease outbreaks

Generic infectious disease surveillance follows a multi-level public health model, where a case or an event first must be recognized as unusual, and then reported and assessed (as a signal). If the case or event meets criteria for further notification, it is reported to higher level authorities and subsequent assessment/investigation ensues. This detection process can be categorized into the following five generic steps: 1) Recognition (of a case or an event); 2) Low level reporting; 3) Low level assessment; 4) Higher level reporting; and 5) Higher level assessment (when

outbreak declaration occurs). While the key players involved at each step will vary by region/country and disease, the basic structure is the same. Inputs into the system include human and animal health events, risks (indicating a potential outbreak), and data.

Novel approaches link up with the generic five-step model at different stages. For example, alarms from syndromic surveillance input into the system as risk (of a potential outbreak), and ProMED-mail and GPHIN provide new data into the system. Both must be followed-up with an epidemiological investigation to determine if and what public health response is needed. Diagnostic tools aid in the assessment steps, and agreements and networks reinforce the entire system by building and strengthening overall capacity for carrying out surveillance activities.

Given the enormous amounts of time and money invested, measuring impact is a priority. There have been a number of analyses that aim to quantitatively measure (in days) the timeliness of infectious disease surveillance systems, seeking to answer the question of how effective these interventions have been.[20-23] Additionally, the IHR (2005), Global Health Security Agenda (GHSA), and U.S. Centers for Disease Control and Prevention (CDC) present useful frameworks for evaluating infectious disease surveillance systems, including timeliness of disease detection.[24-26]

Measuring change in timeliness can help us to hypothesize about effective approaches; however, it doesn't provide information about the causal mechanisms at play. Understanding *why* these surveillance approaches work and don't work will elucidate key drivers of early detection, and enable us to refine and design interventions for *earlier* detection. The important question becomes: *Why* do certain approaches/interventions lead to early detection?

Leading organizations have offered guidelines on how early detection can be achieved. For example, the CDC Working Group produced a prominent guide that is useful and consistent with the landscape of approaches currently operating.[27] However, the recommendations are broad and it is unclear if they are based on evidence.

In this paper, we systematically review the peer-reviewed literature to identify what evidence exists about factors that influence earlier detection of infectious disease outbreaks. This review focuses on the generic public health surveillance infrastructure and includes inputs that novel approaches generate, i.e. risks and data. The goals of this review are to i) synthesize what is

currently known and ii) identify gaps and limitations that can be addressed by future research efforts. Understanding the evidence-base of influencing factors could guide approaches to achieve earlier detection.

Methods

Search Strategy and Selection Criteria

We conducted a systematic review using the PRISMA framework to identify research, published between January 1, 1990 and December 31, 2015 in English language, answering either of the following questions: (1) What are the factors that (a) facilitate earlier disease detection and (b) block earlier disease detection? (2) How can we measure if these factors contribute to an earlier detection time?

Our research question focuses on the drivers of earlier detection and how these facilitating or blocking factors can be measured. Our research focus determines our review selection. The following inclusion criteria were used: any study design; study outcomes include timeliness of event-based infectious disease surveillance (time from event to outbreak realization); measurement of outcomes are quantitative or qualitative; study objectives include identification of factors that influence timeliness of infectious disease surveillance or evaluation of interventions targeting specific influencing factors; events of interest include human, animal, data, or risks; and factors must be modifiable, i.e. amenable to intervention considering the research focus on how influencing factors can be measured. Any studies not meeting all of the above inclusion criteria were excluded.

In addition, the following exclusion criteria were used: surveillance of non-communicable diseases; syndromic surveillance; active surveillance; and individual case detection. Grey literature and perspective pieces were not included in this review.

MEDLINE (PubMed) was searched using the following terms: (Disease notification[mesh] OR Population surveillance[mesh] OR Public health surveillance[mesh] OR surveillance[Title]) AND (Time factors[mesh] OR Timeliness[Title] OR Timelier[Title] OR Time[Title] OR early[Title] OR earlier[Title] OR evaluation[Title] OR evaluating[Title]) AND (Disease outbreaks[Title] OR Infectious disease[Title] OR infectious diseases[Title]).

Study Selection

Two independent reviewers appraised each title and abstract for relevance according to the pre-determined inclusion/exclusion criteria. The inter-reviewer agreement rate was 70% (see additional material). Reviewers resolved disagreements by discussion. Full articles were obtained for all papers included after this first screen. One researcher screened the full texts applying the inclusion/exclusion criteria to determine eligibility.

Using a standardized form, one researcher extracted data from each eligible study. Data extracted included study characteristics, methodology, intervention or surveillance system details, study aim(s), study outcome(s), and influencing factors. The researcher determined whether or not the influencing factors identified in the study were based on evidence or speculation. If they were based on speculation, they were excluded from the review. Influencing factors were extracted manually and organized according to the five-step disease detection model.

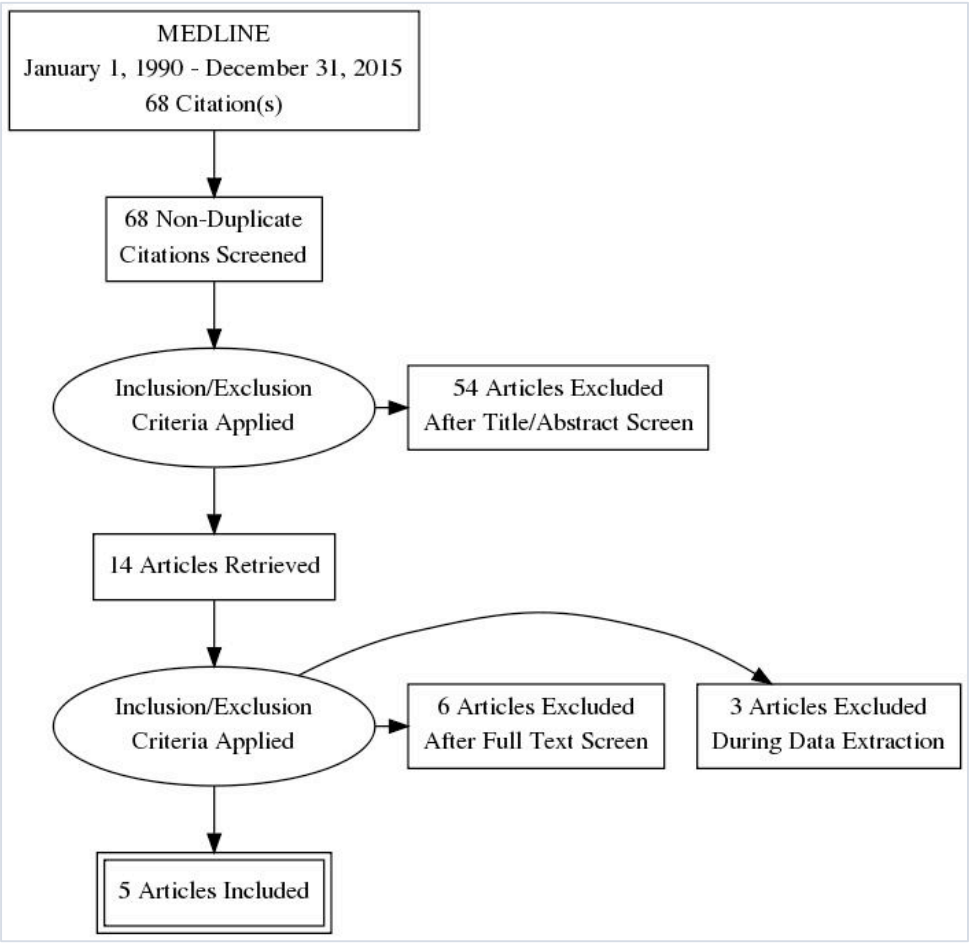

Figure 2: PRISMA diagram

Results

Descriptions of the Studies

The search identified five studies.[22, 28-31] Table 1 summarizes the studies in terms of general characteristics.

Table 1. Summary of Studies

Authors	Year	Location	Data	Diseases
Reijn et al.[20]	2003 - 2008	Netherlands	Dutch national database	Shigellosis, EHEC/STEC infection, typhoid fever, measles, meningococcal disease, hepatitis A, hepatitis B
Panackal et al.[27]	2000	Allegheny County, Pennsylvania, U.S.	UPMC electronic and Allegheny County Health Department paper-based systems databases (derived from the National Electronic Telecommunications System of Surveillance)	Campylobacter, Cryptosporidium, escherichia coli O157:H7, giardia, listeria, legionella, neisseria meningitis, salmonella, shigella, yersinia
Ward et al.[28]	2001 - 2003	Netherlands	National infectious disease surveillance reports	Legionellosis, bacillary dysentery, hepatitis A, pertussis, malaria
Allen et al.[26]	1998	Sydney, Australia	South Eastern Sydney Public Health Unit reports	Hepatitis A, pertussis and measles
CDC[29]	2002-2006	Florida, U.S.	Florida Department of Health web-based reportable disease surveillance database (Merlin)	Salmonellosis, shigellosis, meningococcal disease, hepatitis A

Table 1: Summary of studies

Study Outcomes

Four of the five studies evaluated the effect of electronic-based reporting on detection timeliness. [22, 29-31] These studies were conducted in the United States and the Netherlands, and each defined outcome intervals of interest in days. Of the two studies conducted in the United States, one looked at the time interval between the date/time that the automatic electronic laboratory-based system notification was generated at the hospital and the date/time that the laboratory result was reported to county health department by the conventional paper-based system.[28] The other U.S. study assessed the time from symptom onset to county health

department case notification.[31] Of the two studies that examined electronic reporting timeliness in the Netherlands, one looked at the time intervals of symptom to municipal notification, and laboratory diagnosis to municipal notification,[22] and the other at the intervals between symptom onset and national notification, and municipal and national notification.[30]

The Australian study examined barriers to notification of infectious diseases by general practitioners and identified strategies for improving the notification process.[29] One of the Dutch studies, in addition to measuring impact of different methods of reporting, also measured how the existence of physician-laboratory-Municipal Health Service agreements (that authorize direct reporting by one or more local laboratories) influence timeliness.[22]
Our search did not result in more specific publications revealing evidence on drivers of earlier infectious disease outbreak detection.

Findings of the Studies

Reijn et al. had the following findings: the presence of physician-laboratory-Municipal Health Service agreements showed a significant reduction in notification time to the Municipal Health Service by 5.3 days ($p < 0.01$; 95% CI 1.7-8.9 days), compared to Municipal Health Service without agreements for reporting of hepatitis B in 2008; Municipal Health Service, which received most reports by fax, showed an average improvement in notification time of 3.3 days ($p < 0.05$; 95% CI 0.5-6.1 days) compared to Municipal Health Service which received reports by post; e-mail was slower than fax, though not significantly, and showed no significant improvement compared to post; and Municipal Health Services receiving 10-20 report cards per week from physicians showed a significant delay of an average of 19.1 days for lab diagnosis to Municipal Health Service report, compared to other Municipal Health Services with an average of 7.3 days for lab diagnosis to Municipal Health Service report. The authors conclude that an increase in direct and immediate laboratory reporting of diagnoses to Municipal Health Service would improve timeliness, and that physicians and laboratories were not aware of the importance of rapidly reporting cases.[22]

Panackal et al. found that electronic alerts were reported a median of 4 days (interquartile range 4 days) sooner than through paper-based reporting.[28]

Ward et al. found that the overall median central delay (defined as time between regional and national reporting) was reduced from 10 days (interquartile range 4) in 2001 with a paper-based

reporting system to 1 day (interquartile range 1) in 2003 with an electronic system; and that, except for malaria, the total delay (defined as time between symptom onset and reporting at national level) was also significantly reduced with the electronic system.[30] The authors comment that astute clinicians remain important for timely reporting of certain notifiable diseases.

Allen et al. found the following barriers to physician notification of cases: physicians expected that the laboratory would notify cases (and if doctors left notification to the laboratories, there was an increased delay of 7-19 days); physician uncertainty of diagnosis; lack of remuneration for notifying; notifying is time consuming; and poor specificity of clinical diagnosis or concerns about implications for the patient of notifying a disease later found to be incorrect.[29]

The CDC report found that electronic laboratory reporting would reduce the total time from symptom onset to county health department notification of a case by nearly half for salmonellosis (from 12 days to 7 days) and shigellosis (from 10 days to 6 days), but would produce no change for meningococcal disease (4 days) and minimal improvement for hepatitis A (from 13 days to 10 days).[31]

Analysis of the Findings

We categorized the findings as conditions necessary for earlier detection or factors that influence whether or not these conditions can be in place. Then, we organized the conditions and influencing factors according to the five generic steps in the disease detection model. One study also speculated on factors that may contribute to earlier detection, which is included (and indicated) in the presentation below. (Table 2)

Table 2. Analysis of Studies

	Reijn et al.[20]	Panackal et al.[27]	Ward et al.[28]	Allen et al.[26]	CDC[29]
1. Recognition influencer			Influencing factors Astute clinicians *(speculation)*		
2. Low level reporting influencer	Conditions Information technology Governance Facilitating factors Presence of physician-laboratory-MHS reporting agreements Fax reports to MHS (vs. via post) Blocking factors Physicians and laboratories lack of awareness of the importance of rapidly reporting cases	Conditions Information technology		Conditions Attitudes/beliefs Facilitating factors Public health personnel encourage physicians to seek laboratory confirmation of infections and uncertainty of diagnosis Blocking factors Physician expectations that laboratories send notifications Lack of remuneration for notifying Time consuming to notify Poor specificity of clinical diagnosis or concerns about implications for the patient of notifying a disease later found to be incorrect	
3. Low level assessment influencer					
4. Higher level reporting influencer			Conditions Information technology		Conditions Information technology
5. Higher level assessment influencer					

Table 2 Analysis of studies

Discussion

The evidence-base of necessary conditions and influencing factors for earlier detection identified in this review is sparse. There is some evidence related to reporting (at the low and higher levels), no evidence about influencers of assessment (at the low or higher levels), and only a speculation about recognition at the local level. This limited evidence is surprising given the large and growing size of the field focusing on early detection.

Recognition

Evidence is missing in the area that could perhaps lead to the most improvements in detection timeliness. Local recognition is a critical first intervention area that can enable the detection of an epidemic in its early stage. Epidemics generally begin in small, local areas, and then subsequently spread more widely. While recognition is the earliest possible point for intervention, there is no evidence as to what factors influence earlier detection at this step.

Low level reporting

Low level reporting has the most evidence. A main finding is that electronic reporting is faster than paper-based reporting. This is the low-hanging fruit of early detection. It is intuitive that electronic-based systems will be timelier than paper-based systems. This does not discount the importance of having this evidence, however, it would be helpful to further explore this to understand the factors that influence whether or not these technical capacities can be in place. For example, available financing would certainly influence whether or not information technology structures can be in place. Perhaps a policy or national-level agreement would also be influencers. These types of factors are amenable to intervention, and could facilitate the implementation of electronic-based reporting.

The Reijn et al. findings suggest that establishing reporting agreements, implementing a fax-based reporting system, and raising awareness of the importance of rapidly reporting cases are worthwhile areas for intervention for earlier detection in The Netherlands.[22] The Allen et al. findings of barriers to reporting relate to physician beliefs and attitudes, so trainings and educational seminars might seem like effective interventions.[29] However, by understanding why physicians have the beliefs and attitudes that they do can enable us to intervene further upstream and better target the root causes.

Low & higher level assessment

Low and higher level assessment are complex steps that can involve many players, often across multiple sectors (especially if the pathogen is zoonotic, which the majority of emerging pathogens are[32]). Assessment at the low level might involve physicians, veterinarians, or community health workers depending on the region and disease scenario. If the input into the system is data or risk (for example, if information is picked up via a rumour book or online media story), this might involve local public health, animal health, and/or laboratories. Higher level assessment might involve district, regional, or national public and animal health, and laboratories. Vertical and horizontal communications and coordination are required to carry out assessment activities, including down to the community level. These stages are very complex, and perhaps require the most in-depth thinking. There is currently no evidence on key drivers of earlier detection during assessment.

Higher level reporting

Evidence suggests that information technology needs to be in place for higher level reporting to contribute to earlier detection. Higher level reporting can involve any notification following the initial assessment of an event, data, or risk. For example, the Ward et al. study assessed regional to national level reporting, and the CDC paper focused on laboratory to county level reporting.[30] Both of these reports occur after the initial reports are sent by physicians to the laboratory and, perhaps also, to some district public health authority. The exact flow of notification relies on the disease and context. Both of these studies found that information technology is a necessary condition for earlier detection. Similar to low level reporting, research should build on this to understand the factors that influence whether or not these technical capacities can be in place.

Recommendations

To guide effective interventions and investments for early detection, more research is needed to build evidence on what factors influence earlier detection. EBS was introduced to complement IBS, but for both surveillance systems, it is unclear what leads to earlier detection. Research should consider all steps in the disease detection process, from recognition of a case, an event or risks and data (indicating a potential outbreak), to outbreak declaration. Understanding if and how the various surveillance activities can contribute to earlier detection can enable proper prioritization to achieve maximum impact. Event recognition is the earliest possible point for intervention, and there is currently no evidence as to what factors influence

earlier detection at this step. Low and higher level assessment also lack evidence and are potentially the most complex steps, and can involve participation across sectors and national boundaries. These activities should not be ignored.

The studies included cover a range of geographic regions and pathogens. Needs and challenges will differ across regions and diseases. To ensure utility of findings, studies should focus on regions that are homogenous with respect to factors that could influence earlier detection, such as infrastructure, governance, environmental vulnerability to infectious disease, surveillance systems, and resources. Additionally, the existing evidence comes from the northern hemisphere. Many low income countries—where most of the global population resides—lack the resources or infrastructure to support such activities, and are most at risk for epidemic events.[32] Research should specifically address necessary conditions and influencing factors in these vulnerable regions.

The Reijn et al. and Allen et al. studies measured the contributions of influencing factors to earlier detection, albeit partially. (Allen et al. only measured one of the five influencing factors identified.)[29] The other studies only identified necessary conditions, so were unable measure contributions of upstream factors. Being able to quantify impact of factors on earlier detection can enable balancing of costs and benefits, aid in intervention prioritization, and maximize social return on investments. This will be an important component for future research in this area.

Transparent, replicable, and flexible methodologies can promote development of earlier detection frameworks for different regions. Using similar systematic methodologies for developing evidence can also enable comparisons and potential synergies across and between regions. Pathogens don't respect borders, so frameworks that build on one another could protect against future regional or global outbreaks. We suggest the generic five-step surveillance structure as a model, as it can be applied to any context for any infectious disease scenario.

Outbreak management extends beyond the role of public health, and often requires communication and coordination across multiple sectors and countries. For example, detection of zoonotic infectious diseases requires horizontal interaction between the agencies, departments and ministries responsible for public health, medical professions, veterinary

services, and the environment.[33] Vertical interaction is also crucial for outbreak detection. As outbreaks start *in* communities, involving community members in this early phase could yield important information.

Limitations

This review was restricted to the MEDLINE database. This database is one of the largest and most well regarded biomedical databases available, indexing thousands of high-impact journals. Like any database, though, its coverage is not complete and varies according to the field. Because MEDLINE is the most widely used database in the medical sciences, we decided that restricting to MEDLINE was a sufficient search strategy given existing time constraints.

Grey literature and perspective pieces were not included in the review. Given the size of the field, there is likely much written in the grey literature on how to detect early. However, of the guides and frameworks that we found, it was unclear what evidence, if any, these were based on. We decided to limit our review to the peer-reviewed scientific literature to only capture evidence, and not speculation.

Our review rationale was determined by our research focus to reveal factors that influence earlier detection and ways to measure their impacts. We did not compare different surveillance systems and data collection methods with each other. Thus, our review base was very small. This could indicate that our selection rationale was too strict; or that there is a gap of evidence that can guide improvement of surveillance methods leading to ad hoc decisions on what and how to improve and speed up detection.

Conclusion

Despite significant investments to detect diseases earlier, there is very little evidence on factors that influence earlier detection and measurement of these factors. An evidence-base of the influencing factors can enable more targeted intervention planning. More effective interventions can lead to earlier detection of infectious disease outbreaks, and ultimately, decreased impacts of epidemics on populations. More research is needed on evidence-based factors that influence earlier detection.

Funding

The systematic literature review was a preliminary step in the development of a capacity building programme on risk management and risk communication for CORDS' six regional infectious disease surveillance networks that was supported by The Rockefeller Foundation, Grant Number 2014 SPN 301.

Contributions of authors

LS conducted the literature search and review and drafted the manuscript. EO participated in the search and review and provided substantial comments to the manuscript. PD guided and oversaw the systematic literature review, provided input to the analysis and discussion and substantial comments to the draft manuscript. All authors approve the final version of the manuscript.

Declaration of conflict of interests

The authors declare that they do not have a conflict of interest in relation to this publication.

References

1. World Bank, *Update on the Economic Impact of the 2014-2015 Ebola Epidemic on Liberia, Sierra Leone and Guinea*. 2015, The World Bank.
2. Lam, W., N. Zhong, and W. Tan, *Overview on SARS in Asia and the world.* Respirology, 2003. **8**(s1): p. S2-S5.
3. McCauley, M., S. Minsky, and K. Viswanath, *The H1N1 pandemic: media frames, stigmatization and coping.* BMC public health, 2013. **13**(1): p. 1116.
4. Karamouzian, M. and C. Hategekimana, *Ebola treatment and prevention are not the only battles: understanding Ebola-related fear and stigma.* International journal of health policy and management, 2015. **4**(1): p. 55.
5. Alders, R., et al., *Impact of avian influenza on village poultry production globally.* Ecohealth, 2014. **11**(1): p. 63-72.
6. Heymann, D.L., *Emerging and re-emerging infections.* Oxford Textbook of Public Health. Oxford University Press, Oxford, 2009: p. 1264-1276.
7. Choffnes, E., P.F. Sparling, and M. Hamburg. *Global Infectious Disease Surveillance and Detection: Assessing the Challenges–Finding Solutions*. in *Workshop Summary. Washington, DC: National Academies Press*. 2007.

8. Muyembe-Tamfum, J.-J., et al., *Ebola virus outbreaks in Africa: past and present.* Onderstepoort Journal of Veterinary Research, 2012. **79**(2): p. 06-13.
9. Heymann, D.L. and G.R. Rodier, *Hot spots in a wired world: WHO surveillance of emerging and re-emerging infectious diseases.* The Lancet infectious diseases, 2001. **1**(5): p. 345-353.
10. Eubank, S., et al., *Modelling disease outbreaks in realistic urban social networks.* Nature, 2004. **429**(6988): p. 180-184.
11. Cauchemez, S., et al., *Real-time estimates in early detection of SARS.* Emerging infectious diseases, 2006. **12**(1): p. 110.
12. World Health Organization Western Pacific Region, *A guide to establishing event-based surveillance*. 2008, World Health Organization: Manila.
13. World Health Organization, *WHO Technical consultation on event based surveillance*, in *Meeting report*. 2013.
14. Buckeridge, D.L., *Outbreak detection through automated surveillance: a review of the determinants of detection.* Journal of biomedical informatics, 2007. **40**(4): p. 370-379.
15. Salathe, M., et al., *Digital epidemiology.* PLoS Comput Biol, 2012. **8**(7): p. e1002616.
16. Brownstein, J.S., C.C. Freifeld, and L.C. Madoff, *Digital disease detection—harnessing the Web for public health surveillance.* New England Journal of Medicine, 2009. **360**(21): p. 2153-2157.
17. Caliendo, A.M., et al., *Better tests, better care: improved diagnostics for infectious diseases.* Clinical Infectious Diseases, 2013. **57**(suppl 3): p. S139-S170.
18. Bond, K.C., et al., *The evolution and expansion of regional disease surveillance networks and their role in mitigating the threat of infectious disease outbreaks.* Emerging health threats journal, 2013. **6**.
19. World Health Organization, *International Health Regulations (2005*, W.H. Organization, Editor. 2005, WHO Press.
20. Chan, E.H., et al., *Global capacity for emerging infectious disease detection.* Proceedings of the National Academy of Sciences, 2010. **107**(50): p. 21701-21706.
21. Jajosky, R.A. and S.L. Groseclose, *Evaluation of reporting timeliness of public health surveillance systems for infectious diseases.* BMC Public Health, 2004. **4**: p. 29.
22. Reijn, E., et al., *Analysis of timeliness of infectious disease reporting in the Netherlands.* BMC Public Health, 2011. **11**: p. 409.
23. Yoo, H.-S., et al., *Timeliness of national notifiable diseases surveillance system in Korea: a cross-sectional study.* BMC Public Health, 2009. **9**(1): p. 93.

24. World Health Organization, *Checklist and indicators for monitoring progress in the development of IHR core capacities in States Parties*. WHO.
25. Centers for Disease Control and Prevention, *Global Health Security Agenda: Action Packages*, G. Health, Editor. 2014.
26. Centers for Disease Control and Prevention, *Updated guidelines for evaluating public health surveillance systems; Recommendations from the Guidelines Working Group*. 2001: MMWR Recommendations and Reports. p. 1–35.
27. Sosin, D. M., *Draft framework for evaluating syndromic surveillance systems*. Journal of Urban Health: Bulletin of the New York Academy of Medicine, 2003, 80 (Suppl 1), i8-i13.
28. Panackal, A.A., et al., *Automatic electronic laboratory-based reporting of notifiable infectious diseases at a large health system.* Emerg Infect Dis, 2002. **8**(7): p. 685-91.
29. Allen, C.J. and M.J. Ferson, *Notification of infectious diseases by general practitioners: a quantitative and qualitative study.* Med J Aust, 2000. **172**(7): p. 325-8.
30. Ward, M., et al., *Electronic reporting improves timeliness and completeness of infectious disease notification, The Netherlands, 2003.* Euro Surveill, 2005. **10**(1): p. 27-30.
31. Centers for Disease Control and Prevention, *Potential effects of electronic laboratory reporting on improving timeliness of infectious disease notification--Florida, 2002-2006.* MMWR Morb Mortal Wkly Rep, 2008. **57**(49): p. 1325-8.
32. Jones, K.E., et al., *Global trends in emerging infectious diseases.* Nature, 2008. **451**(7181): p. 990-993.
33. World Bank, *Volume 1: Towards a One Health Approach for Controlling Zoonotic Diseases*, in *People, Pathogens and Our Planet*. 2010.